

ON THE CAUSES OF THE
PROPERTIES OF THE ELEMENTS

MEDIÆVAL PHILOSOPHICAL TEXTS IN TRANSLATION
NO. 46

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ALBERT THE GREAT

**ON THE CAUSES OF THE
PROPERTIES OF THE ELEMENTS**

(LIBER DE CAUSIS PROPRIETATUM ELEMENTORUM)

**TRANSLATED BY
IRVEN M. RESNICK**



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UNIVERSITY

PRESS

MEDIAEVAL PHILOSOPHICAL TEXTS IN TRANSLATION

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ROLAND J. TESKE, SJ, SERIES EDITOR

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ABBREVIATIONS

ANCIENT AND MEDIEVAL WORKS

Albert the Great

<i>De generatione et corruptione</i>	= <i>De gen. et corr.</i>
<i>De nat. loci</i>	= <i>De natura loci</i>
<i>De nutrim. et nutr.</i>	= <i>De nutrimento et nutribili</i>
<i>De prin. motus proc.</i>	= <i>De principiis motus processivi</i>
<i>De XV probl.</i>	= <i>De quindecim problematibus</i>
<i>De veg.</i>	= <i>De vegetabilibus</i>
<i>Metaph.</i>	= <i>Metaphysica</i>
<i>Phys.</i>	= <i>Physica</i>
<i>Super Dion. Epist.</i>	= <i>Super Dionysii epistulas</i>

Algazel

<i>Metaph.</i>	= <i>Metaphysica</i>
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Aristotle

<i>De generatione et corruptione</i>	= <i>De gen. et corr.</i>
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Averroes

<i>Metaph.</i>	= <i>Metaphysica</i>
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Avicenna

<i>Canon.</i>	= <i>Liber canonis medicine</i>
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Ovid

<i>Metam.</i>	= <i>Metamorphoses</i>
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Plato

<i>Tim.</i>	= <i>Timaeus a Calcidio Translatus</i>
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Pseudo-Aristotle

<i>DCPE</i>	= Pseudo-Aristotle, <i>De causis proprietatum et elementorum: Critical Study and Edition</i> , ed. Stanley Luis Vodraska (PhD diss. University of London, 1969)
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Seneca

<i>Naturales quaest.</i>	= <i>Naturales Quaestiones</i>
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ABBREVIATIONS TO SERIES TITLES

Borgnet = Albertus Magnus. *Opera omnia*, ex editione lugdunensi, religiose castigata, et pro auctoritatibus ad fidem vulgatae versionis accuratiorumque patrologiae textuum revocata, auctaque B. Alberti vita ac Bibliographia suorum operum a PP. Quetif et Echard exaratis etiam revisa et locupletata cura et labore A. Borgnet. 38 vols. Paris: L. Vivès, 1890-1899.

Ed. Colon. = Sancti Doctoris Ecclesiae Alberti Magni Ordinis Fratrum Praedicatorum episcopi *Opera Omnia*, ad fidem codicum manuseriptorum edenda apparatu critico notis prolegomenis indicibus instruenda curavit Institutum Alberti Magni Coloniense.

MEDIEVAL AUTHORS

Albert the Great	= A.
Aristotle	= Ar.
Avicenna	= Avic.

NOTE ON CITATIONS

In his notes the translator refers the reader to book, tractate, and chapter number (e.g. 1,1,1). In parentheses are provided the page number for the translation.

ALBERT THE GREAT

ON THE CAUSES OF THE PROPERTIES OF THE ELEMENTS

(*LIBER DE CAUSIS PROPRIETATUM ELEMENTORUM*)

TRANSLATED BY
IRVEN M. RESNICK

INTRODUCTION

Albert the Great stands out among Scholastic philosophers as one of the only figures to comment upon *all* of the writings of Aristotle, including the Philosopher's works on natural science. Among those works, however, Albert had received a number of writings that were ascribed to Aristotle in error but which, nonetheless, had a significant impact upon the development of medieval science. These include the Pseudo-Aristotelian *On Plants* [*De vegetabilibus*],¹ as well as the *On the Causes of the Properties of the Elements* [*Liber*

1 *De vegetabilibus libri VII*, eds. Ernest Meyer and Carl Jessen (Berlin: G. Reimer, 1867; repr. Frankfurt am Main: Minerva, 1982). This text is properly attributed to Nicholas of Damascus.

de causis proprietatum elementorum] that is translated here.² Having accepted it as a work by Aristotle on natural science,³ Albert indicated that his paraphrastic commentary to the *On the Causes of the Properties of the Elements* should follow after Aristotle's *On Heaven and Earth* [*De caelo et mundo*], after his own *On the Nature of Place* [*De natura loci*],⁴ and immediately before *On Generation and Corruption* [*De generatione et corruptione*].

There is no doubt that *On the Causes of the Properties of the Elements* is a genuine Albertian commentary: there exists a copy in Albert's own hand, Codex autographus Vindobonensis 273 (fols. 156r-168v).⁵ The editor of the Latin texts, Paul Hossfeld, suggests that Albert completed his commentaries on both the *On the Causes of the Properties of the Elements* and *On the Nature of Place* between A.D. 1251-54, while he was still teaching at the Dominican *studium generale* in Cologne, and therefore before he was elected prior provincial of the Dominican province of Germany (*Teutonia*). Earlier, in 1248, Albert had been sent to Cologne in order to open the *studium generale* to offer theological instruction to Dominicans, after having spent three years as regent master in the chair for externs at the University of Paris. His student, Thomas Aquinas,⁶ accompanied Albert on foot on this journey from Paris to Cologne. But, in an indication of his scholarly inclinations, Albert insisted in offering at the *studium* not only theological instruction—where he lectured, for example, on the mystical theology of Ps. Dionysius the Areopagite—but also a neo-Platonized Aristotelian

2 Albert the Great, *Liber de causis proprietatum elementorum*, ed. Paul Hossfeld, in *Opera omnia*, vol. 5/2 (Monasterii Westfalorum: Aschendorff, 1980), pp. 49-104. Hossfeld's edition contains both Albert's paraphrastic commentary on this pseudo-Aristotelian work, and, at the bottom of each page, Gerard of Cremona's Latin translation of the text from the Arabic, after an edition established by Stanley Luis Vodraska, *Pseudo-Aristotle De causis proprietatum et elementorum: Critical Study and Edition* (PhD. diss. University of London, 1969). I would like to thank Professor Vodraska for sending me a copy of his typescript dissertation (hereafter DCPE).

3 At *De nat. loci*. 1.2 (Ed. Colon. p. 3, 73-74) A. explicitly identifies *De causis proprietatum elementorum et orbis* as a work by Aristotle.

4 Although this work is Albert's own contribution to medieval geography, he was certainly acquainted with Aristotle's treatment of place in *Physics* 4.1.1-15. See *infra* 1.1.1 (page 19) and note 1.

5 For a discussion of Albert's autograph manuscripts, see Heinrich Ostlender, "Die Autographe Alberts des Grossen" in *Studia Albertina. Festschrift für Bernhard Geyer zum 70. Geburtstage*, ed. Heinrich Ostlender, Beiträge zur Geschichte der Philosophie und Theologie des Mittelalters, Suppl. 4. (Münster: Aschendorff, 1952): 3-21.

6 For Thomas and Albert, see for example James A. Weisheipl, *Thomas Aquinas and Albert His Teacher* (Toronto: Pontifical Institute of Mediaeval Studies Press, 1980).

philosophy and science that he regarded as indispensable to theological studies.⁷ The reason for this was simple: Albert surmised that one can better understand the author of nature from the works of nature.

Albert was not content in his commentary to the Pseudo-Aristotelian *On the Causes of the Properties of the Elements* merely to present a catalogue of scholastic opinions on the natural world. This work instead reflects Albert's conviction that "the aim of natural science is not simply to accept the statements of others, but to investigate the causes that are at work in nature."⁸ It is precisely the causes operative in the natural world that Albert investigated in *On the Causes of the Properties of the Elements*. Albert clearly defines his scientific method there: "We shall, however, touch upon the views of the ancients on this matter so that our teaching may be more secure. And we will confirm whatever we will say about the elements by reference to visible and sensible evidence. For in the natural sciences [*in physicis*], those things that are in accord with sense knowledge are the most certain."⁹ Albert often reiterates this commitment to experiential investigation as the foundation of natural science. In his commentary on the Pseudo-Aristotelian *On Plants*, he added: "Of those things which we will propose some we have proven ourselves through experience; others we report according to the opinions of those we have ascertained do not readily say anything unless it has been proven by experience. For experience alone provides certainty in such matters for the reason that in particular natures a syllogism cannot be applied."¹⁰ Although in *On the Causes of the Properties of the Elements* he is commenting on a text he ascribed to Aristotle, because he understood that his text was defective and missing important parts, he sought to make up for these missing elements with his own discussion and lengthy digressions.¹¹

Even though Albert wrote numerous commentaries on Scripture and many original theological works, in general it is fair to say that it was his work in natural

7 For this neo-Platonized Aristotelianism among German Dominicans, including Albert, see Alain de Libera, "Philosophie et théologie chez Albert le Grand et dans l'école dominicaine allemande," in *Die Kölner Universität im Mittelalter, Geistige Wurzeln und soziale Wirklichkeit*, ed. Albert Zimmermann (Berlin: Walter de Gruyter, 1989): 49-67.

8 *De mineralibus* 2.2.1 (ed. Borgnet, p. 30).

9 *Infra* 1.1.1 (page 20).

10 A., *De veg.* 6.1.11 (ed. Jessen pp. 339-40).

11 See *Liber de causis proprietatum elementorum*, 1.2.2 (Ed. Colon, p. 62, 53-p. 63, 5).

science, with its commitment to a scientific method rooted in experience,¹² that achieved the widest popularity and distribution in the Middle Ages.¹³

THEMES AND CONTENT OF THE BOOK ON THE CAUSES OF THE PROPERTIES OF THE ELEMENTS

As Albert explains in the first chapter, the work will be divided into two parts. The first will investigate the natural properties of the elements, and the second will examine their accidental properties. His scientific methodology seeks empirical evidence once again to support his conclusions since “in the natural sciences those things that are in accord with sense knowledge are the most certain.”

The investigation into the elements and their properties directs the reader’s attention first to the fundamental building blocks of nature. Following ancient Greek philosophers and Arabic commentators, the text identifies the four elements that are mixed to form the composite bodies of the sub-lunar world: earth, air, fire, and water. In addition, Albert considers the presence of a fifth element or quintessence in the celestial sphere, which is also a cause of composite bodies, not through its substance but through the power that it has infused into other bodies. Each of the four elements has its own natural place. Earth, because it is heavy in an absolute sense, will naturally be found below; fire, because it is light in an absolute sense, will naturally rise upward. Water and air are relatively heavy or light, in comparison with these other two, and can be found therefore in between.

The first controversy Albert considers stems from the opinion of certain ancient philosophers who had proposed that fire is not an element at all, but seems rather to be an effect of celestial movements. The argument, which Albert’s discussion rejects, contends that fire is produced by the rubbing or friction of heavenly

12 For Albert’s scientific methodology and for his significance as a natural scientist, see William A. Wallace, “The Scientific Methodology of St. Albert the Great,” in *Albertus Magnus. Doctor Universalis 1280/1980*, ed. Gerbert Meyer and Albert Zimmermann (Mainz: Matthias Grünewald Verlag, 1980): 385-407; Benedict M. Ashley, O.P. “St. Albert and the Nature of Natural Science,” in *Albertus Magnus and the Sciences. Commemorative Essays*, ed. James A. Weisheipl (Toronto: Pontifical Institute of Mediaeval Studies Press, 1980): 73-102; Edward A. Synan, “Albertus Magnus and the Sciences,” in *Albertus Magnus and the Sciences. Commemorative Essays*, ed. James A. Weisheipl (Toronto: Pontifical Institute of Mediaeval Studies Press, 1980): 1-12; W. P. Eckert, “Albert der Grosse als Naturwissenschaftler,” *Angelicum* 57(1980): 477-495; and Paul Hossfeld, *Albertus Magnus als Naturphilosoph und Naturwissenschaftler* (Bonn: Albertus Magnus Institut, 1983).

13 See Bernhard Geyer, “Die handschriftliche Verbreitung der Werke Alberts des Grossen als Maszstab seines Einflusses” in *Studia mediaevalia in honorem admodum Reverendi Patris Raymundi Josephi Martin*, OP (Bruges: De Tempel, 1948): 221-228.

bodies against the air that exists between the concentric spheres that delineate the Aristotelian cosmos. According to this cosmology, in general acceptance among medieval astronomers, the heavens were themselves a series of nested spheres or concentric circles. At the center was the immobile earth, which was surrounded by the proper “places” or spheres of the other elements, namely, water, air, and fire. Beyond these, each of the seven planets had its own sphere. These seven are the moon, Mercury, Venus, the sun, Mars, Jupiter and Saturn, usually in that order.¹⁴ Beyond these was an eighth sphere that contained the “fixed” stars, i.e., stars whose movement did not appear to “wander” like the planets. Finally, in the ninth sphere was the prime mover, which carried the lower spheres around with it daily from east to west in a diurnal motion. If fire is produced from the “friction” between the planetary bodies or their spheres and the air that separates them, then fire is not elemental at all but is produced from other already existing materials; consequently, fire cannot be a primary element, since air, the spheres, and the heavenly bodies must exist first. The identity of the “ancients” mentioned by our author (and by Albert, as commentator) is uncertain.¹⁵ At times, Aristotle speculates in a similar fashion. He seems to hold that the heavenly bodies—which are constituted from a fifth element or quintessence—are not themselves hot, but rather that both heat and light are produced as a result of their motion. As the spheres containing these celestial bodies rotate, the friction caused by rubbing against the air beneath them produces heat and light, causing the air to “fire,” perhaps producing the sphere of fire from the air. From an empirical standpoint, Aristotle understood that when a leaden ball or missile, for example, is shot through the air, it becomes hot as it passes through the air. Analogously, the movement of the spheres against the air below causes light and a fiery heat.¹⁶ Our text invokes, however, the names of Plato and Democritus and their disciples, who argued analogously that fire is caused by rubbing or friction, as for example when steel strikes flint, or when pieces of wood are rubbed vigorously one against another, to produce a spark or flame.

Here Albert objects and attempts to dismiss any notion that fire is not one of the four primary elements but only a secondary product of motion or friction. If it were the case that fire is produced only from the friction of one of the celestial spheres against the air separating it from the next sphere (which assumes somewhat controversially that air exists in the celestial realm), then “there are many fires,” or there must exist as many types of fire as there are celestial spheres

14 See *infra* p. 22.

15 Vodraska speculates that it may be Theophrastus, the author of *De igne*. This work is available in a critical edition with English translation. See *Theophrastus De igne. A Post-Aristotelian View of the Nature of Fire*, ed. Victor Coutant (New York: Humanities Press, 1971).

16 See John Thorp, “The Luminousness of the Quintessence,” *Phoenix* 36.2(1982): 104-123.

rubbing against air. Moreover, he argues, the motion of the heavens does not produce such violent rubbing or friction as would be necessary to produce fire. Nor, finally, can one conclude that even if fire were produced from the motion of the spheres that it is not, then, a primary element, for each of the four elements is produced from one of the other elements “in a circular fashion,” although as a simple element and not as a composite of matter and form. Fire, then, is a primary element alongside the other three mentioned.

Thus having established that earth, air, fire, and water are the four primary elements our text proposes that all bodies in our sublunar sphere are material composites mixed in some proportion from these four. Animate bodies also have, however, a soul that is immaterial—not only in humans, who possess a rational soul, but also in lower animals and even plants. However, animate nature is not produced immediately from a mixture of the four elements. First, these elements are combined to produce the intermediary bodily humors or their analogues. Animals are constituted from these humors in a proximate way, and therefore not immediately from the elements. In this sense, minerals and metals are closer to the primary elements from which they are composed than is animate nature, which is commixed instead from the elemental derivatives, i.e., the humors. These humors, which have their own qualitative complexion, are yellow bile or choler, which is hot and dry; blood, which is hot and moist; black bile or melancholy, which is cold and dry; and also phlegm, which is cold and moist. When the proper balance of the humors is disturbed in a body, it leads to illness, corruption, or putrefaction, which underscores why it is so very important for physicians to understand the relationship between the elements, the humors, and the body. If the body becomes “distempered” or loses that humoral or complexional balance that should exist in it, then it will be subject to illness, corruption, and ultimately death. When there is a proper balance of the elements or humors for a specific type of body, the mixture is not produced simply by mixing one part earth to one part water (or one part blood to one part phlegm), however. Rather, the mixture in discrete bodies expresses a geometric ratio. There may, then, be more earthiness or more wateriness in one body than another, more melancholy or phlegm, and consequently relatively more coldness or moistness. This ratio and its qualities will influence the behavior of that body: if earthiness is dominant then the body will tend to be heavy and dense, like rocks and metals. Those in which there is more of air’s heat and moistness will be lighter and rise up, helping to explain, for example, the ability of birds to fly.

Next, our text examines the origin of properties like cold and heat. Are these essential or natural properties of the elements, or are they accidental properties? If they are accidental and not essential properties, then the elements can exist without them. Again, citing Plato, Democritus, and their followers the text notes that these philosophers supposed that cold is an essential property or principle for the elements, whereas heat is generated from them in an accidental

fashion—e.g., from the sun’s movement across the heavens. Clearly, some areas of the world are more or less hot, and the heat or cold of these various *climata* or climes correlates with their nearness to the sun and its orbit, leading to a discussion of the habitable regions of the earth.¹⁷ In response to the argument that cold is an essential elemental principle or property, while heat is an accidental product of the sun’s movement, once again our text disputes the conclusion of “Plato and Democritus” to argue that both heat *and* cold are natural or essential properties. Water is “naturally” cold just as fire is “naturally” hot. These features do not depend on the sun’s heat, but are intrinsic qualities.

The sun’s movement (or that of other planetary bodies) only explains *excessive* heat or cold. Because heat and cold are natural properties, it also stands to reason, according to our text, that certain locales or geographical regions will reveal natural differences in climate. Areas near the seashore will be cooler and more humid, because of the presence of water, which is cold and moist, so long as other factors do not complicate this picture.¹⁸ Nonetheless, these natural qualities can be influenced by celestial movements that enhance or diminish an existing heat or cold, as well as by other, accidental influences, for example: wind, elevation above sea level, and so on. This will be the case not only for our physical environment, but also for our own bodies. Consequently, inhabitants of the first clime, the one nearest the equator, are rendered very hot and dry by the sun’s heat and by the long days in that region. Because human bodies in this region will be very hot and desiccated by environmental or celestial influence, even the male’s semen—a bodily fluid—will be exceedingly hot, affecting the quality and the appearance of progeny produced from sexual intercourse between male and female. Following classical geographers, then, our text supposes that black Africans (collectively named “Ethiopians”) derive their color principally from the environmental effects of the sun’s burning heat, which also causes their hair to become very curly and “crisp” as a result of this burning.¹⁹ However, it also

17 For a helpful discussion of the development of medieval theories of the climates or *climata*, see John Block Friedman, *The Monstrous Races in Medieval Art and Thought* (Syracuse: Syracuse University Press, 2000), chapter 3.

18 E.g., the reflection of the sun’s heat off of broad, sandy beaches.

19 Although one might be inclined to treat this as a Western prejudice, Arab cosmographers shared the same assumptions, derived from Greek antiquity, and transmitted them to the West. Thus, the eleventh-century Arabic *Book of Curiosities*, attributes the black color of Ethiopians and Sudanese to the intense effects of the sun near the equator. The effects are, again, not merely apparent upon their external appearance. Similarly, animals in these regions are likewise affected by the drying heat of the sun. See fol. 26b, lns. 6ff. In like manner, Albumasar’s influential *Introductorium maior*, tr. 3.3, for example, explains that as a consequence of this excessive heat and dryness, “Ethiopians” will not only have a distinctive black color on the outside, but internally too they are afflicted with a fatuous light-mindedness and deficient intelligence. For

acknowledges this influence not only upon the external appearance of the body, but also upon its internal processes, as in the case of its influence upon the semen and sexual generation, suggesting at the same time a hereditary transmission of effect. In contrast to those in the equatorial first clime, those who live in northern climes (like Albert's own Germany) are colder and moister, producing in them a white or very fair complexion, as well as a distinct mental "temperament" resulting from these qualities. Elsewhere Albert explains that the cold and moisture of northern climes produces in the humans there a natural boldness and talent for war, whereas those like the "Ethiopians" found in exceedingly hot and dry regions will be naturally timid and unwarlike, as well as fatuous and frivolous.²⁰ This is not only the case for humans, but will be evident, Albert argues elsewhere, in the entire animal kingdom. Thus, he insists, it is not coincidental that in the far north one will encounter polar bears or snow hares that are white,²¹ whereas in more southern regions bears and hares or rabbits are brown and darkened by the sun's heat and rays.

Having discussed these matters in the first tractate of book one, in the second tractate Albert turns to more specific properties of the elements and, in particular, to the question: do the heavens produce *sound* as a natural or accidental property? Is there a harmonic, as some ancient philosophers supposed, caused by the motion of the spheres that goes unnoticed by us because it is so constant and because we are habituated to it from birth? Once more, our text rejects the doctrine of the "music of the spheres" and, employing an argument drawn from physics, reasons that just as a sound typically grows louder or softer the nearer or farther we are from its source, so too if the spheres produced sound, its volume should vary as the planetary bodies draw nearer to us or farther away. Since we notice no such change in volume, there can be no music of the spheres. One cannot argue that we are habituated to an unchanging harmonic of the heavens because the heavens change and move in relation to us, becoming more or less distant, as geometric proofs clearly show.

Just as the doctrine that the movement of the spheres produces a harmonic is dismissed, so too will be the doctrine that celestial movements cause the oceans to move across the entire globe over a long period of time, and that alluvial motion explains the production of mountains and valleys. Even though the evidence of a ship's oar or rudder buried deep under ground or the presence of sea shells or fossilized remains suggests that in the past the ocean or sea was present in areas not now under water, Albert insists that there is no persuasive evidence

the text, see *Liber Introductorii maioris ad scientiam iudiciorum astrorum*, ed. Richard Lemay, vol. 5[2] (Naples: Istituto Universitario Orientale, 1996), p. 98.

20 See A., *Quaestiones super de animalibus* 7.28 (Ed. Colon. pp. 183,77-184,1); *De nat. loci* 2.3 (Ed. Colon. p. 27,2-4).

21 A., *De nat. loci*. 1.8; 2.4 (Ed. Colon. p. 15, 62-63; 28, 64-68).

that oceans or seas have moved entirely from one place to another upon the earth's surface. Nor, as he explains later, can we infer that mountains have been created by the power of the sea or rivers to cause erosion. A better explanation, he suggests, is that mountains have been created by earthquakes forcing upward the hard crust of the earth.

Nonetheless, this dispute over the relationship between mountains and the movement of the waters leads to an important discussion of tidal movements and floods. These phenomena are especially attributed to the movement of the sun and moon, although all planetary motions may have some influence. This is especially true for the moon, because it has itself a watery and earthy nature that produces a special influence on the ebb and flow of waters here below. The sun, raising vapors from the waters by virtue of its heat, may also generate strong winds that influence the movement of bodies of water on earth, causing sea swells. Meanwhile, Albert explains, one can calculate high and low tides accurately only once one understands the moon's orbit, just as one can calculate sunrise and sunset once one knows the sun's orbit. But just as the moon affects the very visible rise and fall of the tides here below, its waxing and waning equally influences the humors of the body—the human body, as well as the bodies of plants and animals. In the human body, the woman's menstrual flow is directly linked to the moon, while the ripening of fruits is likewise tied to the moon's virtue or power to influence complexion in plants. For the same reasons, the alchemist working to produce purer metals, Albert allows, must pay special attention to the power of the moon.

If the moon has such power to influence the ebb and flow of tides as well as the level of the humors in the body, is it also the cause, Albert queries, for the universal Noachide flood identified in the Bible that once covered the whole of the earth, which Albert regards as identical to the flood that occurred during the age of Deucalion and Pyrrha recounted in pagan literature? In this case, Albert explains, he is not seeking to explain the *theological* causes for the biblical flood but only the *natural* causes that God employed to bring about the result he desired. Although Albert agrees that the moon had some influence, he assigns the principal cause of the universal flood to a spectacular planetary conjunction in the sign of Pisces, when all seven planets were conjoined in a single sign of the zodiac. In addition, other causes contributed to produce this universal flood. When only some of these causes are present, or when they are present with diminished power, Albert opines, they may cause a particular rather than a universal flood, flooding only one area rather than covering the entire earth.

Having examined the properties of water, Albert turns next to the properties of air and fire. Once more, he articulates and then dismisses a number of views attributed to ancient philosophers or natural scientists. Of special interest for him is volcanic activity. Since it is fire's nature to ascend and rise up, because it is absolutely light, how does one explain the presence of these volcanic fires

beneath the earth? Furthermore, if a conjunction of the seven planets is principally responsible for the universal flood of water, can we also explain a universal 'flood' of fire, or a universal conflagration described by Plato, as the result of a specific alignment of the planets? Once more, Albert remarks that the alignment of planets can explain a conflagration of the sort expressed mythically in the story of Phaeton. His curiosity extends as well to a further question: If, because of the universal flood, certain animal species were entirely destroyed, how could they be restored later, in the absence of a breeding pair? Once more, the power of the stars may revive a species that had been destroyed, even in the absence of a female whose womb would normally be required for generation. This, Albert proposes, is because the womb is not required for generation in an absolute sense, but only "for the sake of well-being, namely, so that it [the animal] may be better formed" whereas celestial motions are ultimately responsible for generation and corruption. Without a breeding pair, the stars can still reproduce the species of perfect animals, just as the influence of the stars can impair the act of generation, resulting in monstrous births.

In the second book of this work, Albert investigates the nature of earth. In particular, he refutes both the theory of the earth's rotation and a belief that the sphere of the fixed stars is infinite. Albert treats the two as connected insofar as if the sphere of the fixed stars were infinite, then it could not possibly complete a revolution in a finite period of time, and certainly not in twenty-four hours. Our text also refutes claims that the earth is not a true sphere, but that it "bulges" at one end, and equally rejects arguments that the southern hemisphere is elevated more than the northern hemisphere. If the southern hemisphere were elevated more than the northern hemisphere, then the seas in the south would naturally overflow and submerge locations in the north. But this is contrary to experience.

Other chapters in the second book investigate the causes that produce natural hot springs and volcanoes and, as already indicated, examine too the origin of mountains and valleys, which Albert attributes to the force of earthquakes rather than the alluvial motion of seas or rivers.

Finally, Albert concludes, "since in this book we have made a determination concerning the properties of simple bodies... a division that we mentioned at the beginning of our [book on] *Natures*,²² demands that we discuss, God willing, the generation and corruption of things subject to generation and corruption." With this, Albert prepares the reader for the treatise to follow this work, namely, *On Generation and Corruption*. Where *On the Causes of the Properties of the Elements* explores the elements and their properties that coalesce to form composite bodies, *On Generation and Corruption* will examine the process of generation, decomposition, or death.

22 See A., *Phys.* 1.1.4 (Ed. Colon. pp. 6,39-8,14).

TEXTUAL TRADITION

The translator of the Pseudo-Aristotelian *On the Causes of the Properties of the Elements* was likely Gerard of Cremona (d. 1187). It was Gerard who translated from Arabic into Latin a book entitled *On the Property of the Elements* [*De proprietate elementorum*] or *On the Causes of the Properties of the Elements* [*De causis proprietatum elementorum*]. According to Stanley Luis Vodraska, who prepared a critical edition of the Latin text of *De causis proprietatum et elementorum*, the Latin translation was likely completed by Gerard of Cremona shortly before his death in 1187. The source that he translated was incomplete. The list of Gerard's translations, compiled shortly after his death, refers to his translation of a book by Aristotle entitled *De causis proprietatum et elementorum*, but it identifies the Latin translation as comprising the first tractate together with only a part of the conclusion from the second tractate. It may have been Gerard who was responsible for attributing this work to Aristotle. Based on internal evidence, Vodraska concluded that the Arabic source was likely written in Iraq between A.D. 830-875, "and possibly in al-Basra between 830 and 850."²³ The true identity of its author remains unknown.

Regardless of the work's origin, its medieval authority as an Aristotelian work remained unchallenged and its influence spread, leading Pierre Duhem to remark on its importance for scholastic scientific theory.²⁴ Professor Vodraska identified at least 106 extant copies of the Latin translation from the Arabic entitled *De causis proprietatum et elementorum*. He prepared his edition using twelve of these manuscripts, and compared manuscript readings to the four subsequent printed editions: Venice, 1496; Venice, 1552; Venice, 1562 and 1573.²⁵

Albert the Great had obtained, then, a manuscript copy of the Latin translation, to which he added commentary and his own lengthy digressions. Albert's text and commentary *On the Causes of the Properties of the Elements* [*Liber de causis proprietatum elementorum*] appeared in the printed editions of his *Opera omnia* prepared by Jammy²⁶ and Borgnet,²⁷ before it was edited by Paul Hossfeld in the Cologne edition of the collected works of Albertus Magnus.²⁸ Hossfeld

23 Vodraska, *DCPE*, p. 60.

24 "Le livre *Des propriétés des éléments*, que l'on croyait être d'Aristote, eut une grande influence sur les théories scientifiques de la Scolastique;..." Pierre Duhem, *Études sur Léonard de Vinci*, 2nd series (Paris: A. Hermann et fils, 1909), p. 309.

25 These two merely reproduce the Venice 1552 edition. In addition, the Venice 1562 edition is reprinted in Frankfurt am Main, 1962.

26 B. Alberti Magni Ratisbonensis episcopi Ordinis Praedicatorum Opera... edita studio et labore R. A. P. F. Petr. Jammy, S. Theol. Doct. conventus Gratianopolitani (21 vols.; Lyon, 1651), 5: 292-329.

27 *Opera omnia*, ed. A. Borgnet (38 vols.; Paris: L. Vivès, 1891), 9: 585-657.

28 See *supra*, n. 2.

used Vodraska's critical edition, which is reproduced at the bottom of the page below Albert's text and commentary; but Hossfeld also compared Vodraska's edition to three thirteenth- and fourteenth-century manuscripts that contain Albert's text and commentary, making corrections he deemed necessary.²⁹ In all, Hossfeld lists thirty-three codices containing manuscripts with the complete text of Albert's *On the Causes of the Properties of the Elements* and eight additional codices containing excerpts or fragments of the text. This number exceeds by more than a factor of two the number of extant manuscripts of even the most popular of Albert's biblical commentaries.³⁰ Although the largest number of manuscripts dates from the fourteenth and fifteenth centuries, Hossfeld lists three manuscripts that are dated confidently to the thirteenth century: the autograph copy, Codex autographus Vindobonensis 273 (fols. 156r-168v) = Wien, Österreichische Nationalbibliothek 273; Oxford, Magdalen College 174 (fols. 76va-86vb); and, Rome, Bibliotheca Apostolica Vaticana, Vat. Lat. 718 (fol. 19rb-38vb).³¹ Our translation is based on Hossfeld's critical edition.

29 See Hossfeld's prolegomena to *Liber de causis proprietatum elementorum* (Ed. Colon., pp. ix-x).

30 See Paul Hossfeld, "Die Ursachen der Eigentümlichkeiten der Elemente nach Albertus Magnus," *Philosophia naturalis* 14.2(1973), p. 197.

31 *Liber de causis proprietatum elementorum*, p. xv.

HERE BEGINS BOOK ONE

ON THE CAUSES OF THE PROPERTIES OF THE ELEMENTS

TRACTATE ONE IS ON THE NATURAL PROPERTIES
OF THE ELEMENTS IN GENERAL

BOOK ONE

CHAPTER ONE

WHAT THE AIM OF THE BOOK IS AND CONCERNING THE PROPERTIES OF THE ELEMENTS, WHICH ARE LIGHT AND HEAVY, FROM WHICH DISCUSSION THE ERROR OF THOSE WHO SAID THAT FIRE IS NOT AN ELEMENT IS SHATTERED

Since, however, we have already completed in general in the *Physics* the things that had to be said concerning the nature and distinction of places,¹ it seems to us that it remains that we explain the properties of the elements that they have from the sphere and from their places. And in this work following the chief teacher of philosophy, Aristotle, we will introduce two individual books by which we will complete this science. In the first of the books we will explain the natural properties of the elements, and in the second we will provide instruction on the accidental properties that sometimes bring about corruption of the elements, in such a way that they are not corrupted from the species, but their qualities are corrupted.

Let us state, then, that after we presented a natural [*physicus*] doctrinal discussion of the heaven and earth and made an adequate determination concerning it,² because we introduced there a discussion of the natures and accidental qualities [*passiones*] of what is subject to motion in a circle and what is subject

1 A., *Phys.* 4.1.1-15 (Ed. Colon. pp. 201,4-230,40); *De nat. loci* 1.1-5 (Ed. Colon., pp. 1,6-9,46).

2 A., *De caelo et mundo*, 1.1.3, 1.2.3 (Ed. Colon. p. 7,84-11,76; 38,38-43,3); and book 3 (Ed. Colon., pp. 202-245)

to motion in a straight line, it seems to us that there still remains something about the knowledge of those things that are subject to motion, namely, their properties and accidental qualities. And for this reason we are introducing this book to determine all the properties of the elements both of those placed on high, where the fifth element exists, as well as of those in a lower place, where the four elements exist.³ Our method, however, is concise and brief in such a way, nonetheless, that it is adequate for a knowledge of the properties of the four elements. We shall, however, touch upon the views of the ancients on this matter so that our teaching may be more secure. And we will confirm whatever we will say about the elements by reference to visible and sensible evidence. For in the natural sciences [*in physicis*], those things that are in accord with sense knowledge are the most certain.⁴ For it is necessary for us to know every property of the elements before we speak of the change of bodies through generation, corruption, alteration, and growth, because the elements are the principles of those changes.⁵ And unless the natures and accidents of the elements are well understood, the natures of all those things caused by them will not be known.⁶

But from those things that we said in the book *On Heaven and Earth*, it is known that the elements are of two kinds.⁷ For there is a certain first efficient cause of bodies that does not enter into their composition through substance and being, but infuses its powers [*virtutes*] into all things both simple and composite, and this is called the fifth element. It is distinct from all the others, but bears a certain similarity to an element in that it is itself the first to cause composition and is unmixed with the composite by its power.

The other elements, however, are four in number, and in a material sense they are the ingredients of composites and are the first matter of bodies. They are known from what we said several times in preceding books.⁸ But among them there is one that is light in an absolute sense and another that is absolutely heavy, and

3 The "fifth element" or quintessence. In the twelfth century, William of Conches explains that Aristotle believed that in addition to the four elements, from which all things from the moon downward are composed, there is also a fifth essence from the moon upward, and that everything above the moon is either the fifth element, or consists of it. He adds, "He [Aristotle] divides the fifth essence into ether and firmament; he places in the ether the seven splendid bodies called the planets, while he places in the firmament the infinite bodies that are the fixed stars." William of Conches, *A Dialogue on Natural Philosophy (Dragmaticon Philosophiae)*, 3.5.2-3, trans. Italo Ronco and Matthew Curr (Notre Dame, Ind: University of Notre Dame Press, 1997), p. 47.

4 See A., *Phys.* 1.1.1 (Ed. Colon. p. 3,31-37).

5 See A., *De caelo et mundo* 3.2.1 (Ed. Colon. p. 220,13) and 3.1.1 (Ed. Colon. p. 202,42).

6 See A., *De caelo et mundo* 1.2.1 (Ed. Colon. p. 32,25-27).

7 A., *De caelo et mundo* 1.2.1 (Ed. Colon. p. 32,21-23).

8 A., *De caelo et mundo* 1.1.4-6; 1.1.9; 3.2 (Ed. Colon. p. 11,77-17,93; 21,27-24,63; 220,1-245,49); *De gen. et corr.* 2.1.8-10 (Ed. Colon. p. 183, 3-184, 36).

there are those that are lighter than others and heavier than others.⁹ For earth, which is cold and dry, is heaviest among all the elements, not having only a relative heaviness, but heaviness in an absolute sense. Heaviest among all the elements after earth is water, which is cold and moist. The one that is heaviest after these two, however, is air, which is hot and moist. Fire, however, is not heavy at all, but rather rises up above all things.¹⁰ And if fire were said to follow these three elements in being the least heavy, the comparison would be misapplied, unless fire should be separated into two types, namely, fire that exists in its own proper matter, and fire that exists in a foreign matter that is not perfectly assimilated to fire. And the first certainly has no heaviness whatsoever. The second, however, has some heaviness, which still does not result in the act of descending lower, and for the reason that such material is overcome by fire's form.

But because earth has been made the heaviest of the elements, it is therefore the lowest in place. And because fire has been made the lightest of the elements, it is therefore the highest among them in place. However, the two middle elements, which are air and water, have obtained the middle place. And all these issues have been dealt with in the third and fourth books of *On Heaven and Earth*.¹¹

However, some of the first philosophers did not agree on the number of the elements that has been stated. For they said that fire is not an element, because it does not seem to be a first among bodies, but has another one before it according to nature. For they say that it is generated by the motion of a celestial body from another element, which is air. For they reasoned, saying that no body is an element if it is generated from another, since an element is that which is first, from which other things are generated. Fire, however, which is lighter than all of those that are in a place, only comes to be from the friction of the air against the heaven from the motion of heaven. For, as we said in the book *On Heaven and Earth*, fire's heat is caused by the friction from the heaven's movement between two genera, of which one is air, which is the matter for fire, and the other is the motion of heaven, which is the efficient cause and introduces the form of fire.¹²

However, they introduce an example of this, saying that exudation of moisture is not an element because it comes to be from the heat of the sun's rays and from the moisture of the earth as its matter. And this is why fire does not seem to be the first of the efficient or material bodies. And since there are not many first bodies, fire does not appear to be an element, since an element is supposed by everyone to be first with respect to genus of a body that is efficient and with respect to genus of a body that is material.

9 See A., *De caelo et mundo* 1.2.3 (Ed. Colon. p. 40,16-17); 4.2.4 (pp. 261,34-262,64).

10 See A., *De caelo et mundo* 1.2.3 (Ed. Colon. p. 40,54).

11 A., *De caelo et mundo* 3.1.1 (Ed. Colon. pp. 202,1-203,29).

12 A., *De caelo et mundo* 2.3.1 (Ed. Colon. pp. 143,82-144,34) and 2.3.2 (Ed. Colon. pp. 144,34-146,12).

It is necessary, however, to contradict them from what they presuppose. For they say that air is a body extending as far as heaven and that it is between the spheres [*sphaerae*]¹³ of the heavens and that it is only changed into fire by the motion of heaven. Therefore, if what they say is true, then it is necessary for them to say that there are many fires. For one fire will be generated between the sphere [*orbis*] of the moon and the sphere of Mercury, and another again between the sphere of Mercury and the sphere of Venus, and still another between the sphere of the sun and the sphere of Venus, and another between the sphere of the sun and the sphere of Mars, and another still between the sphere of Mars and Jupiter. And fire will also be generated between the sphere of Jupiter and Saturn, and between the sphere of Saturn and the sphere of the fixed stars fire will be generated from a cause like the one they mention, namely, the friction of the sphere against the air or the friction of sphere against sphere. But the greatest of these fires will be the one that is between the sphere of Saturn and the sphere [*sphaera*] of the fixed stars, because the sphere of the fixed stars is larger than all the lower spheres, and has more bodies in it, which are called stars, since each of the lower spheres has only one body.¹⁴

Therefore, according to the views stated here, that body which fills in between the spheres [*sphaerae*] will be a fiery body generated from air that exists there, arising from the friction of some higher sphere against its lower counterpart.¹⁵ And those philosophers from the sects of Plato and Democritus and of certain others certainly conceded this, introducing an analogy based on the fact that they see that fire is generated when iron is struck against a rock. By "iron" I mean something that is formed like steel and is called a steel.¹⁶ In addition they introduce an analogy based on trees that are situated on mountains, where the air has free access, or that are densely planted on deserted plains that are open to the wind on all sides. For when the wind blows against them stormily and tempestuously with a powerful blast, fire arises from their rubbing one against another, and it consumes the trees. This occurs especially in the dry season and in

13 In what follows A. mainly uses *orbis* to indicate a sphere. When he uses *sphaera*, it will be noted so that the reader can come closer to the original sense of the Latin.

14 A., *De caelo et mundo* 2.3.15 (Ed. Colon. p. 176,9-178,98).

15 The argument seems to be that fire is produced by the friction or rubbing of the heavenly spheres against the air that exists between them. Therefore, fire is produced from prior materials and comes to exist only after air and the heavenly spheres already exist. As a result, it cannot be an element, since an element must exist first, and other things will come into being from it. Albert's criticism suggests that if this understanding of fire arising from friction were correct, then there would have to exist as many different fires as there are distinct spheres that produce it.

16 The sense of this "steel" is clearer in A.'s received text than in his interpretation. What is being discussed is a "steel" which is struck against a piece of flint to produce a spark. The Latin word in question is *focile*.

a dry region where the trees do not abound with an excess moisture to extinguish it, or in those trees in which there is an oily and greasy moisture, as there is in the fir and in pine trees. But they further adduce an analogy based on diggers. Sometimes a hard rock is struck by them as they come down with force, and then fire suddenly flashes out. But many analogies like these can be adduced, because many are found in the natural sciences [*in physicis*] as well as in the arts.

It is unnecessary for us to be very solicitous with respect to a solution for these matters, because we have made a determination concerning them in the book *On Heaven and Earth*, where we showed that this body is not susceptible to foreign or extraneous impressions, and that this is why the same qualities are not generated in the nature of heaven as are generated in other bodies.¹⁷ Nor does such violent friction exist there, since heaven's motion is not contrary to heaven's nature, but is in accord with nature, even though the first mover is an intelligence.¹⁸ It is clear from the final part of the book *On Heaven and Earth* that air does not reach it, because it does not rise up above all things since it is not light in an absolute sense.¹⁹ Nor is the argument appropriate that concludes that something generated from something else is not an element. For each of the simples is generated from some other in a circular order.²⁰ But if from something there were generated that which is posterior to it in terms of form and it remained in what was generated in terms of power and were first, then what was generated in this way from something else would not be an element. However, none of these things are true for the generation of fire, even if it were asserted to be generated from air, as will be determined in the book *On Generation and Corruption* [*Peri geneseos*].²¹ The generation of the elements from one another is circular, but still because nothing but the matter is preserved in that generation in what was generated, for this reason what is generated is simple, just as it is generated from something simple, and each one is an element, although one is before the other in time in a generation such as this. Nor is what they say true, that fire is generated from air by friction. For air does not ascend to fire's place, even if fire is understood to be removed from its place. And for this reason the first body that is generated in the vault of heaven comes not from air, but rather

17 A., *De caelo et mundo* 1.3.2 (Ed. Colon. p. 145,19-22; 145,94-98).

18 See A., *De caelo et mundo* 2.2.6 (Ed. Colon. p. 139,4); 2.3.14 (Ed. Colon. p. 175,2-176,9).

19 A., *De caelo et mundo* 4.2.4; 4.2.6 (Ed. Colon. p. 261,34-262,64; p. 265,55-266,64).

20 In other words, although the elements are incorruptible when taken as a whole, nonetheless individually one is always changing into another. Fire is continuously transformed into earth, air into water, and vice versa.

21 A., *De gen. et corr.* 2.3.6 (Ed. Colon. p. 207,39).

the fire is there the first that is produced in the elemental matter, as we said in the book *On Heaven and Earth*²² and in the book *On the Nature of Places*.²³

CHAPTER TWO

ON THE PROPERTIES OF THE ELEMENTS IN MIXED BODIES

In order not to wander too far afield about the questions raised by the ancients concerning the number of the elements, since we are not concerned with such things here, but rather with the properties of an element, let us return to the topic, touching upon whatever properties an element has in a composite that is constituted from elements.

Let us say therefore that the composition of all animals and of any composite bodies arises from four bodies that are called elements and that are their matter. All composite bodies are mixed together [*commixta*] from these first four, and there are the operations of the elements in composite bodies, which we determined in the book on *The Nature of Places*.²⁴ Nevertheless, some bodies withdraw further from the elements in their operations, and some withdraw less. Those that withdraw less from them are rocks and minerals. For in these we expressly see the operations of the elements, because they are composed directly from the elements. Plants, however, in which we see the operations of an imperfect soul, withdraw from them more, and this is why such bodies follow the operations of the elements, although they are not composed directly from them.²⁵ But it is necessary that there be produced a tempering of the elements in seed and sap or of that which exists in place of seed and seminal humor where a spirit is making the plant germinate.²⁶ The bodies of animals, however, withdraw most of all and for this reason are not generated proximately from the elements,²⁷ but it is necessary for the elements to be mixed into humors and for the bodies of animals to be constituted from the humors.²⁸ Although the humors [*umores*] are all moist [*umidi*] in act, which is why they are called humors, they still contain the power [*virtus*] of each element. For a mixture is found in which yellow choler dominates, which is hot [and] dry, following the properties of fire. And another is found in which blood dominates, which is hot and moist, following the properties of

22 A., *De caelo et mundo* 4.2.4; 4.2.6 (Ed. Colon. p. 261,34-262,64; p. 265,55-266,64).

23 A., *De nat. loci* 1.3 (Ed. Colon. pp. 4,42-6,7).

24 E.g., fire's power to heat or water's power to moisten will also be present in those bodies mixed from these elements. See A., *De nat. loci* 2.1-3 (pp. 23,16-27,83).

25 See A., *De veg.* 1.1.5 (ed. C. Jessen p. 19).

26 See A., *De veg.* 2.1.1 (ed. C. Jessen p. 110).

27 See A., *De veg.* 1.2.4.50-55 (ed. C. Jessen p. 74).

28 See A., *De animalibus* 12.1.4 (ed. H. Stadler pp. 817-19).

air. Still another is found that comes from phlegm, following the properties of water to the extent that it is cold and moist. And another is found that comes from black choler, which is called melancholy, which is cold and dry, having the powers of earth. But it is up to the physician to make a determination concerning the generation and diversity of these humors.²⁹ For we intend here only to discover the property of the elements in composite bodies.

We will say, however, in the following books on natural science that things composed from these four materials do not possess them equally according to an arithmetic proportion, but rather according to a geometric proportion, because it is necessary that there be more blood or more of the humor that is in place of blood in any animated body.³⁰ Nonetheless, these³¹ four materials in mixed bodies admit corruption and an unnatural increase beyond that which is due to a body, and they sometimes admit an unnatural diminution and dissolution of the harmony [*harmonia*] that is due to a species or to an individual of any animate [body]. And these changes are brought about with the matter and not in a quality alone. However, this imbalance³² of the harmony sometimes occurs without matter in a quality alone when, even though no matter is corrupted in the body of the animal, their bodies are changed either from heat to an excessive cold or from a natural cold to an excessive heat or from a natural moisture to an excessive dryness or, conversely, from a natural dryness to an excessive moisture. For this reason the wise men among physicians also consider whether an illness is caused by a humor corrupted with the matter or from an intensified or diminished quality of the humor without any corruption of the humor's matter. And if the illness comes from a corrupted matter, they prescribe purgatives [*evacuativa*] because it is necessary to remove the corrupt humors lest they cause the bodies to putrefy. However, if it is caused from the quality alone without the corruption of the humor's matter, they only prescribe alteratives³³ [*alterativa*] and not purgatives, because it is bad and injurious for bodies to be purged of an uncorrupted humor. Therefore, when one of the component elements is added

29 That is, the physician must determine whether an individual is choleric or melancholy, for example, and whether this is because of illness or from the effects of diet or some other factor.

30 That is, the four humors are not found in a 1:1 relationship, but rather in geometric proportions or ratios of 1:2, 1:3, etc. See A., *De gen. et corr.* 1.6.9 (Ed. Colon. p. 174,41-175,18); *De animalibus* 12.1.2.17; 12.1.4.55 (ed. H. Stadler p. 804; 819.); *De veg.* 4.1.2 (ed. C. Jessen p. 223).

31 Reading "hae" for the rather difficult neuter plural "haec."

32 "Imbalance" [*distemperantia*] implies a preponderance of one quality over another, whereas a body that enjoys good health is one in which the humors are properly balanced or "tempered."

33 An alterative is a medicine that alters the processes of nutrition and restores their healthy action.

to a commixed body beyond the measure of the proportion needed to constitute a body in a species or in an individual, then an injury is produced in the body that has been constituted. In the same way an injury occurs when one of the component elements is reduced and there is not as much of it in the body as there ought to be.

In addition, however, if it happened that one of these elements occupies something that has been composed from them all, it would bring about destruction and dissolution, since the place in which a composite is preserved is itself composite, as we showed in the preceding book.³⁴

Likewise, however, if it happened that a composite is entirely deprived of one element, such a composite could not remain in existence, but would be dissolved. For if an animal were entirely deprived of air, it would not last, for which reason nature prepared members for fish and other aquatic animals, in which they contain the airy breath, because without air breath neither exists nor is nourished in the body of a human or of any other mixed body. For the mixture is produced by means of the breaths that are operating in bodies, and the powers are distributed and dispersed by the breaths of the mixed bodies. But through the action of fire a perforation is produced in order to create pathways for the breaths. But, insofar as it pertains to our present purpose, we have said enough about these things in the book *On the Nature of Places*.³⁵

In the same manner, if simple air that is not somewhat dense occupied an animal, it would die, and an indication of this is that we see that those animals that fall from a very high place, where the air is pure, seem to die not from the fall but rather before they reach the ground. But the experiential evidence [*experimentum*] for this is twofold: there is of course one example that is observed in the art of climbing, for if one falling from a high place is deflected from the line of his fall, he will impact the ground only as hard as if he fell from the place where he received the deflection. For if someone should fall from a tower and someone else should intercept him three cubits³⁶ before he falls to earth and should push him away with a hand transversely from the line of his fall from the tower, the one falling will impact the ground only as hard as he would have from a fall of three cubits. However, if he should fall from a very high place and be deflected from the line of the fall, he is still found dead. And for this reason it is known that he did not die from the fall but because he has been filled with simple air. Another bit of experiential evidence is that their dead bodies are found with signs of death that are not from the impact, because they do not swell up from the fall or do not bleed and have no other humoral signs of impact. For this reason

34 A., *De nat. loci* 1.2 (Ed. Colon. p. 3,65-79).

35 A., *De nat. loci* 2.1 (Ed. Colon. p. 23,52-63).

36 A cubit is a unit of measurement that might vary in length from about 18 inches to 22 inches.

those who climb very high mountains have also carried along sponges dampened with water in front of their noses, so that the air breathed through the sponges would become denser.³⁷ However, the cause for this is of course that pure air is instantly and easily rendered hot or cold. This is also why pure air, once it has been breathed in, does not retain the cold, but is immediately warmed by the animal's body and by the motion and heat of the lungs. On this account, when this air comes to the heart, it heats up the heart and kills it. However, denser air better retains the external coldness, and this coldness is not removed from it by the body's heat and the motion of the lungs. And this is why when denser air comes to the heart, it cools it and nourishes life and conserves it in the animal. However, if the animals are not breathers, then they are cold by nature, and they are corrupted by the contrary nature of a higher place to a lower one, as fish die outside of water.

Something analogous occurs when one with commixed humors is occupied by fire, because fire has a very vigorous action, and this is why it quickly drives out the internal moisture, on account of which the earthy part of a composite is separated and that which was composed from the elements is corrupted. Something similar occurs among those things occupied by pure water. For although fish live in water, they are not nonetheless preserved and nourished by simple water, but rather by mixed and composite water, as we will show in the books *On Animals* [*De animalibus*].³⁸ But the same argument exists also concerning simple earth, in which all composites that are dissolved³⁹ by nature, putrefy. And this is why what some of the ancients reported is not true, namely, that four animals can live in simple elements—the salamander in fire, and the mole in earth, and the herring [*altec*] in simple water, and the fish that is known as a sturgeon [*sturio*] in air.⁴⁰ It is unnecessary for us to seek an argument against these, since it is known that everything that exists is generated from and nourished by the same things, and since each of these is mixed from the four elements, it is also necessary that they be nourished from something commixed and not simple.⁴¹ We will discuss

37 See A., *Meteora* 2.1.12 (Ed. Colon. p. 52,60-65).

38 A., *De animalibus* 7.1.3.26-29 (ed. H. Stadler p.536,5ff.).

39 "Dissolved," implying reduced to their constituent parts.

40 For the salamander, see A., *De animalibus* 25.2.34(46) (ed. H. Stadler pp. 1570-72); on the mole, *De animalibus* 7.2.4.123 (ed. H. Stadler p. 548), 8.1.2.13 (p. 576), and 22.2.1.143(105) (pp. 1425-26); on the herring, see *De animalibus* 24.1.8(2) (p. 1518), and 1.1.3.38 (p. 15); on the sturgeon, see *De animalibus* 7.3.2.151 (p. 561), 8.3.120 (p. 622), 13.2.1.82 (p. 930), and 24.1.49(105) (pp. 1543-44).

41 At *Quaestiones super de animalibus* 1.4.2 (Ed. Colon. p. 82, 33-45) A. explains too that since all animals are compounded from the four elements, and all are generated from and nourished by the same things—a principle he found in Ar., *Historia animalium* 1.1 (487a17-18, 28-29)—it is impossible that any animal live in a pure element, as some have argued that the chameleon and the mole, the herring and the salamander live on

these things, however, in the book *On the Nourishment of Living Things* [*De nutrimento animatorum*].⁴²

Therefore, we find that certain things dwell in the waters, like fish and marine reptiles. For the mixed water becomes for them like a balanced and tranquil place, and on this account they are cold and moist, and this is why they dwell in it and die when they leave it. However, nothing is found to dwell in fire, even if we suppose a mixed fire as fire is in an earthy substance, on account of the excessive action and consumptive nature of its heat.

CHAPTER THREE

ON THE PROPERTIES OF THE ELEMENTS IN COMPOSITES

WITH RESPECT TO THE POWERS

THAT THEY HAVE FOR LOCAL MOTION, WHICH

PROPERTIES ARE HEAVINESS AND LIGHTNESS

But it follows that we should determine the properties of the elements that they have in mixed bodies in terms of the potencies [*potentiae*] and powers [*virtutes*] by which they are disposed for locomotion. But this motion is found especially in mineral and plant bodies, which do not have a motion that arises from a soul, but which have the motion of the dominant element in them.

For it is asked about these why some of them float over the water and some are submerged under it, since generally in all such bodies the heavy, lower elements dominate.⁴³ But we will here assign the universal and necessary cause, because we are not here preparing a treatise and an investigation concerning the nature of particulars.

Therefore, let us say that the cause for submersion is that the earthy part prevails in the composite body, not only in the matter, but also in the quality that determines [*terminare*] the composite to its form and species. But all such things are those that are earthy and both are in accord with and are coagulated by a cold that presses out the moisture that is diffused in them, as are rocks and the metallic [substances] that are iron and bronze. For, although these may be liquefied by heat, and for this reason water appears to dominate in them, earthiness still prevails over what is subtle in them, and they are all coagulated by cold. On this account the cold compresses their "pores"⁴⁴ so that air is not

pure elements (e.g., a salamander in fire). Since an animal is mixed or compound, its nourishment and environment must be mixed. See *Quaestiones super de animalibus* 3.18.1; 7.7.2; 12.1.2 (Ed. Colon. p. 133, 18-29; 175, 26-35; 224, 32-39).

42 A., *De nutrim. et nutri.* 1.4 (ed. Borgnet, vol. 9, p. 331b).

43 The heavy, lower elements are water and earth, whose natural place is below whereas fire and air are light and tend to rise upward.

44 "Pores," that is, openings or spaces in the bodies themselves.

trapped in them, and for this reason they sink under water by the weight of the earth that prevails in them.

But something similar occurs in those in which water dominates, both in terms of matter and in terms of the cold that determines them. For either these do not have pores, or they have pores that are smaller and more constricted than airways are, and this is why it is necessary for them to sink, because although they are watery, they still would not be mixed bodies if they had no earth, and this is why they are heavier than water that is uncompounded,⁴⁵ and they sink beneath it. However, it is quite different if some of these are consumed by fire's burning. For in these the inherent moisture is removed by the violence of fire, and its pathways remain filled with air. Hence, these have many and evident pores that trap the air within them, for which reason they are found to float, as do rocks like pumice⁴⁶ that are burned up, porous, and hard. But it is clear from these examples why wood, with but few exceptions, floats. This is because wood is porous and airy, although the nature of earth prevails in it. For a natural heat separates it to spread nutriment through it, and when the natural heat passes out of it and removes the inner moisture, it remains loose-textured [*rarum*] and porous. An indication of this is that more of those [woods] that float are found to be dry rather than green, and those that do not float are found to be solid and without pores, like ebony⁴⁷ and black oak.⁴⁸

What seems more surprising to everyone is that some that sink still contain an oily moisture, like ebony when it is shaved. Its kindling is fatty and oily and bursts into flame, and yet ebony sinks in water, even though oily woods do not sink, as we will mention a little bit below. But the reason for this is that there is certainly very little oiliness but a great deal of earthiness in ones like this, and the constriction of the pores is quite pronounced from the power of the earthy cold, and for this reason the oiliness that has been overcome sinks with the earthiness that prevails over it. However, when the opposite occurs, that is, when the fiery and airy part prevails [*vincit*], it floats. This "victory" [*victoria*] never occurs in composites with respect to matter. For in all composites the lower elements prevail, as we will show in the second [book] of *On Generation and Corruption* [*Peri geneseos*].⁴⁹ For we see that, with respect to matter, earth and water prevail in all minerals and plants and animals.⁵⁰ Therefore, this victory is according to

45 "Water that is uncompounded" = *aquae simplices*, i.e., water that consists of only a single element.

46 See A., *De mineralibus* 1.1.2 (Borgnet, p. 3).

47 See A., *De veg.* 2.1.6 (ed. C. Jessen p. 135).

48 See A., *De veg.* 4.1.31 (ed. C. Jessen p. 440); *Meteora* 4.2.17 (Ed. Colon. p. 284,9)

49 A., *De gen. et corr.* 2.2.17 (Ed. Colon. pp. 199,69-200,50).

50 A., *De veg.* 2.1.1 (ed. C. Jessen p. 105), 4.3.1 (ed. C. Jessen p. 254); *De mineralibus* 1.1.2 (Borgnet, p. 3).

the operation of the quality that determines it to its species and form. For heat that fills what is loose-textured [*rara*] and porous produces a substance in which the air existing in act causes the bodies to float.

The cause is similar for why flyers [*volatilia*] float and fly upon the air. For, to speak in general, the flesh of winged creatures is light, for which reason it is judged to be more healthful even by physicians. But from the lightness they have an aptitude for flying, and their flesh is airy and hot. But the large number of feathers and plumes shows this, because feathers are airy and loose-textured and light. But when a feather has newly emerged in birds when they are young, it is filled with a sanious aqueous humor, for which reason it is heavy and not fit for flying.⁵¹ But when a natural heat and heat containing air have removed the aqueous moisture, there remains something earthy, light, split apart, and filled with air, which is hardened by the maturation of the heat so that it does not bend easily, and then it becomes an instrument for flying and lifts the bird upon the air. However, animals that have heavy flesh, in which an airy moisture does not prevail, do not fly, but they either walk or crawl on the ground. But in much the same way aquatic birds, which have cold and heavy flesh, have few feathers and a slow and short flight.

Oils and fats, which all float on water owing to the fat airy moisture prevailing in them, provide an illustration of the things that have been said. For this reason when such things have been eaten, they float upwards and cause upset and nausea unless they are cleansed and pushed down by something eaten later, like a sharp cheese or something else of this sort. For the heat that is in them makes them liable to rise up [*elevativa*], and especially when it is united to moisture because then it is inseparably ensnared in the moisture, as it were, and it can only be lifted up when it lifts up the moisture with it. However, when heat is without moisture, it still escapes and lifts up [*elevat*], but then quickly withdraws, leaving behind as dry the things by which it had been embodied, and then having been separated from the heat, they tend downward. For this reason things that are dry and hot are not observed to float upwards like hot and moist things, but to cut the upper parts through which the dry and sharp heat, which has fire's motion and property, escapes.

There is also another cause for this. For the hot and the moist have a vaporizing action, because the hot dissolves and the moist provides the matter for dissolu-

51 A., *De animalibus* 7.3.4.169 (ed. H. Stadler pp. 567-68). At *De animalibus* 2.1.6.69-75 (ed. H. Stadler pp. 252-56) A. examines in detail the anatomy of "flyers" [*volatilia*], i.e., winged creatures, and their many types or kinds. He is clear that not all birds are "flyers", since some birds are earthbound, and not all flyers are birds. A. acknowledges that the ancients identified winged serpents, and these should be included among the "flyers" (*De animalibus* 1.1.7.95, ed. H. Stadler p. 35). Nonetheless, most "flyers" are feathered, winged birds.

tion, and for this reason they are prone to expansion and, owing to the expansion, they are driven to higher places. This is then the reason why they float upwards.

However, it is much the same in those things opposite to these that do not float, in which cold dominates over the earthy, like ebony wood and boxwood and very old oak.⁵² For in all of these, especially when they have lain in water for some time, the pores are blocked, and for this reason earthiness that is separated from air remains in them, and this is why they sink.

CHAPTER FOUR

ON THE REFUTATION OF THE ERROR OF THOSE WHO SAID THAT COLD IS NATURAL TO THE ELEMENTS AND THAT HEAT IS ACCIDENTAL

But with these things having been determined, it is necessary for us to investigate whether the qualities that belong to the elements, whether they be simple in their own right or whether they are mixed in composites, are proper and essential to the elements, so that they [the elements] cause them, or whether they are accidents that befall them and whether it is possible that the elements exist as elements without them. And this is especially an investigation into the existence of cold and heat, that is, whether they are the foundations, that is, principles, of the elements or whether they are their accidents. For many of the first philosophers who came before us in philosophy discussed this matter. In fact, Democritus and Plato—and those who follow both of them because they agree in part with each of them in their discussions on the natural sciences—said that cold is a foundation and an essential principle for the elements, whereas heat is generated from something else and is an elemental accident and not a principle. But they took the basis of proof from an example, since they saw that what is in harmony with an element in itself and as a result of what is intrinsic to it is essential, whereas what is caused extrinsically is accidental. However, heat is not in itself present in the elements that touch us, because then it would be in them all the time, but it rather comes to them from the sun's approach to its zenith directly overhead. For when the sun turns away from our habitable zone, moved on its own ecliptic decline in a southerly direction from right to left, then an excessive cold befalls us from the very nature of the elements, as they say, which the sun does not overcome when it turns away from us. For they call it the right side of the ecliptic of the sun, which is from Aries to Libra, because then the sun ascends hot and is moving everything that exists toward generation, but it loses strength, as on the left side, when it is in the southern signs from Libra to Aries.⁵³ And this occurs relative to our habitable zone and not absolutely.

⁵² See A., *De veg.* 6.1.9 (ed. C. Jessen, p. 359) and 1.2.11 (p. 99).

⁵³ See A., *De caelo et mundo* 2.3.3 (Ed. Colon. pp. 146,13-148,22).

But in like manner places that are far toward the side of the north pole, which are very distant from the line where day and night are equal,⁵⁴ which is the equator, are very cold, so that some of them are uninhabitable because of the cold. But places that are close to the same equinoctial line, which are near the zenith directly overhead, are hot, owing to the direct aspect of the sun. And all these matters are clear from the determinations that were made in the preceding books.⁵⁵ But such a change of the air and of the elements from the sun's direct and oblique aspect is perceived by sense experience. Therefore, heat is seen to be generated from the sun's approach and from its retreat, but cold seems to be produced from the elements themselves. Thus, heat seems to be accidental, and cold seems to be essential to the elements, and this is the basis for their argument that heat is generated from the movement and the direct aspect of the sun, whereas cold is found in them without these things, when the elements are at rest.

Let us say, then, that they had a correct opinion when they said that motion and, similarly, the sun's approach generates heat, because these are found to be the case from sense experience. For in this doctrine they agree with us, but they depart from us in the conclusion, because we say that heat is natural to certain elements, just as cold is a natural quality for certain elements. For sight attests to the fact that earth is cold and dry, which earth is, I say, nearest to us among the elements. Earth is also perceived by touch to have these two qualities. Water, however, is cold and moist and without doubt is near to us. Therefore these two elements are near to us and are essentially cold. However, there are two elements that are hot that are further removed from us, and they are not hot owing to the sun's rays, but they are hot from themselves. However, the fact that cold appears next to us here in the air touching us when the sun retreats from us, is not owing to the fact that air is essentially cold, but because the two cold elements near us cool it. But although there is such an excess of cold or heat from the sun's approach or retreat, these two qualities are still essential to different elements, as we said. For it is quite possible that something that is an accidental agent produces some form in the natural world [*in physica*], but that the form introduced is still natural, and this is the case in everything capable of undergoing change that is naturally receptive of that form, just as fire receives heat. And we determined this in the *Physics* where we said that an agent is always extrinsic, but that one undergoing change still receives form naturally, when the potential [*potentia*] exists in it.⁵⁶ Thus, although heat is generated from motion, it is still natural to the fire's matter.

54 I.e., the equator, which is midway between the two poles.

55 A., *De caelo et mundo* 2.3.2 (Ed. Colon. pp. 145,86-146,12); *De nat. loci* 1.8 (Ed. Colon. pp. 14,78-15,87).

56 A., *Phys.* 7.1.5 (Ed. Colon. pp. 527,45-528,79).

But whether the first qualities of this sort—which are the hot, cold, moist and dry—are substantial forms of the elements or their proper affects [*passiones*] will be demonstrated in the book *On Generation and Corruption* [*Peri geneseos*], because we are not here dealing with the substances of the elements, but only with their properties.⁵⁷ However, although an excess of heat and cold is produced near the region of our habitation from the sun's approach or retreat, our habitation will be continuous and pleasant. The principle for this is both the fundamental balance and the tempering of the first qualities. For since the place and what is placed in it enjoy a shared nature [*connaturalitas*], those qualities will be the principle of a place that are the principle of what is placed in it.⁵⁸ But in all the bodies of animals the principle and foundation is a balance between excess and diminution, which is called the temperament.⁵⁹ For health consists of this balance in those things that are mixed from contraries. But illnesses and pernicious injuries arise in animals as a result of a departure from the temperament to an extreme excess of the hot or cold or moist or dry, as we said above.

It is quite certain, then, from the things that have been said that the existence of cold is caused from the nearness of the two cold elements. But the existence of heat in the elements is natural to the two higher elements, which do not approach us more at one time than at another. However, the existence of heat and cold around our habitable zone is caused by the approach or retreat of the sun and of the other planets in an oblique orbit, and this [heat] is the principle of generation, existence, and life through a balanced temperament, and illness and injury are caused by excess.

CHAPTER FIVE

ON THE PROPERTIES OF THE ELEMENTS IN THEMSELVES AND IN COMPOSITES, WHICH ARE CAUSED BY DIFFERENCES IN PLACE

However, the elements possess in themselves as well as in mixtures certain properties natural to them from [their] place, and in order to know these it is necessary to state the properties of the places of the earth, of the shores, of the seas, and of the mountain ranges, and the accidents that are generated in the habitats of these places, and the natures of the people living in these places. For although we have already discussed these things in the book *On the Nature of Places*,⁶⁰ it is still necessary to touch on them here in order to complete instruction on the properties of the elements.

57 A., *De gen. et corr.* 2.2.7 (Ed. Colon. p. 190,14-69).

58 See A., *De nat. loci* 1.2-4 (Ed. Colon. p. 3,80-81; 4,77-79; 7,12-13).

59 See A., *De anima* 1.2.8 (Ed. Colon. p. 39,3).

60 A., *De nat. loci* 1.4-5 (Ed. Colon. p. 6,8-9,46); tr. 2 *passim*.

I say, therefore, that the inhabitants of the first clime, which is the one nearest the equinoctial circle—which is called the equator, because when the sun touches it night is equal to day—acquire excessive heat and excessive dryness owing to the constant fixed presence of the solar rays over their heads, and cold and moisture are reduced in them. And this is why the semen of these men stems from hot foods and matures in the body from a great heat, and when it empties into a woman's womb, the womb is hot and cooks it with a great cooking action. For this reason, too, the bodies of those born all participate in an intense blackness, and they have curly hair.⁶¹ For the fluid [*aqua*] that is the man's semen is cooked in the hot and dry womb, and menstrual blood is mingled with it, and it coagulates so much that it becomes a bit like a piece of flesh, and then it is formed and shaped into the members. And a rational soul, which is not educed from matter, but is created and imparted externally, comes to be in it⁶² by divine command and order, as we will show in the divine science [*scientia divina*].⁶³ But the cause for this blackness and for the curly hair is that the sun travels above them in a perpendicular fashion twice each year, ascending once from Aries to Cancer and descending once from Cancer to Libra. For in equal signs the sun is moved over the same place. But Aries and Virgo, and Taurus and Leo, and Gemini and Cancer are equal signs; therefore the sun is moved over the same place in the two equal signs. As a result, it appears twice over the heads of those who dwell between the summer tropic and the equinoctial [circle]. On account of this, they have two very hot seasons because, as we said, it passes the zenith [*casus lapidis*] over their heads twice, that is, the line drawn in a perpendicular fashion over their heads from the center of the sun. For this [zenith] is called "the rock fall" [*casus lapidis*] because a rock and anything that is heavy in an absolute sense falls downward in a perpendicular fashion, as if to describe two right angles on a plane surface drawn mentally through the center of the earth. For the sun passes the zenith once when it ascends from the equator, which the beginning of Aries touches at the beginning of Cancer. But it passes the same

61 As A. explains just below, the development of dark or black skin and other characteristics that moderns typically view as racial characteristics can instead best be explained by environmental influences: e.g., the sun's heat and the dryness of the locale, among others, which not only affect a body on its surface but also its internal organs, development, and gestation.

62 Grammatically, "it" refers back to the semen. A. reflects here the dominant anti-traducianist position that a soul is not passed down from one generation to the next through its material link (the semen), in the same way as the body or its characteristics are passed down to produce 'genetic' propensities—e.g., as red-haired parents will often produce red-haired children—but rather the soul is infused immediately by God from outside the body.

63 A., *Metaph.* 11.1.9 (Ed. Colon. p. 473,30 and 78 with note); see *Phys.* 1.1.1 (Ed. Colon. p. 3,41).

zenith over their heads a second time, when descending, when it returns from the remotest point of its descent from the north, which is the remotest point where the beginning of Cancer touches the summer tropic when returning to the beginning of Libra, which touches the equator from opposite of the beginning of Aries. In this way a very strong heat occurs among them twice a year. But the other stars, which are called planets, and the moon make such transits while passing very quickly over their heads. For all of these participate in the sun's operation owing to the light borrowed from the sun. But for the same reason those who are from India, those from the city of Iamen, and the Zyndi⁶⁴ and all Ethiopians are black and curly-haired and dry. For in all of them there appears a black color and curliness to their hair.

In those, however, who dwell in the seventh clime, which is nearest the North Pole and far from the equator and from the path of the sun and of the other planets, opposite qualities occur for the opposite reason. For these are all cold, and their places are quickly cooled, and this is why the wombs of the women are cold and moist, and for this reason an intense whiteness and fairness [*subalbedo*] occurs in them, as occurs among the Slavs and the Parthians⁶⁵ and those of Dacia⁶⁶ and the Teutons and Angles and such nations of this sort, which dwell around the shore of the northern ocean. All these have the kind of form that has been described.

But those who dwell in the middle climes have colors that are mixed together from white and black. These dispositions of the places, however, vary also because of accidents of the places, such as depth⁶⁷ and shores of the sea and mountains and other things of this sort.

In this way, therefore, we have shown what pertained to our purpose concerning the properties of the elements [arising] from [their] places. But we find heat on the sea shores, although the shores are not near the sun's path, and if they are next to the sun's path, then the heat is multiplied on the shore beyond that of other places of the same latitude. And the reason for this is that when the sun beats upon the breadth and expanse of the sea water, the heat is multiplied from the reflection of the rays, and this heat is driven by the water's coldness toward the shores. This is the reason that the shores become warm, unless by some accident the heat of the shores is driven back, perhaps for the reason that there are very often lofty mountains on the shores that reach as far as the cold

64 Vodraska identifies *Iamen terra* as Yemen (DCPE, pp. 111, 293) while the Zindi he identifies as those from East Africa (p. 111).

65 Parthia = Middle Persia, an area, A. remarks, some call "Media." See *De nat. loci* 3.6 (Ed. Colon. p. 39, 37).

66 An area of Southeastern Europe which, A. remarks, borders Saxony (see *De animalibus* 2.1.4.50; ed. H. Stadler p. 244). See *De nat. loci* 3.3 and 3.7 (Ed. Colon. p. 36, 38, and 41, 1).

67 By "depth," *profunditas*, A. appears to have in mind elevation above sea level.

of the air, which are open to the north wind and are closed to the south. For since mountains are vaporous, dew and rain are continually generated from the mountains, which the blowing of the north wind congeals into ice and perpetual snow, and for this reason such a mountainous shore grows cool.⁶⁸ But where this accident is not present, there the shores become hot for the reason already stated.

But an indication of this is that if cold water is placed in a very clean and reasonably round glass, like [the beakers] for urine, and is placed directly opposite to the ray and eye of the sun, the heat is multiplied from the reflection of the ray upon the glass, and the great heat is driven behind the glass by the water's coldness. And if there is there a very clean and dry cloth that is a little parched, it will be set on fire, and fire will be elicited from it.⁶⁹ And this does not happen if hot water is placed in the glass, because something hot does not repel and concentrate, but rather attracts and rarifies, and for this reason it weakens the heat generated by the reflection of the rays. Therefore, the concentration of the heat to the glass opposite it is on account of its flight from the water's coldness, because heat and cold are contraries and one flees from the other.

We have, however, spoken with certitude about the property of places in the book *On the Nature of Places*, and for that reason we do not repeat those things here, but pass on to other things.⁷⁰

68 See A., *De nat. loci*. 1.13 (Ed. Colon. p. 22, 20-29).

69 A. treats this phenomenon again at *Quaestiones super de animalibus* 4 annex., 3 (Ed. Colon. p. 149, 4-30).

70 A., *De nat. loci* 1.5-13 (Ed. Colon. pp. 8,9-23,10).

THE SECOND TRACTATE OF THE FIRST BOOK
ON THE CAUSES OF THE PROPERTIES OF THE
ELEMENTS, WHICH CONCERNS THE PROPERTIES
OF THE ELEMENTS IN PARTICULAR

CHAPTER ONE

ON THE PROPERTY OF THE NOBLE ELEMENT, THAT IS,
HEAVEN, IN WHICH IT IS SHOWN THAT
HEAVEN DOES NOT MAKE A SOUND

But since we have already stated the elements' properties that generally occur in them, both in themselves, when they are simple, and in composites, for that reason now in order to complete the instruction we shall introduce in particular the natural properties of any element, beginning with the first noble element, that is, heaven. Some of the wise naturalists [*physiologi*] have said of this that it receives foreign impressions just like another element. And this is why they said that with its motion it produces a whistling sound and a sound of great harmony from its friction with another body—whether of its own kind, as when a sphere touches sphere, or of another kind, as when a sphere touches fire or air, which they claim rises as far as heaven—which [sound], owing to the habit of hearing it from birth, we do not nonetheless perceive by distinguishing it from silence and from other sounds.⁷¹ For a sense does not perceive things similar and connatural to it, as touch does not perceive a natural heat, but those things that are discerned by a sense are rather those that surpass it and are dissimilar to it. Since, then, the familiar is natural and akin to nature, for this reason they say that hearing gets used to this sound and does not perceive it.

However, we already have conducted an investigation into this question in *On Heaven and Earth*.⁷² But because we have here undertaken to determine all the properties that the noble element has through its relation to the elements, for this reason it is also necessary to speak here of it otherwise than we did in *On Heaven and Earth*, and we will provide a demonstration of strong and sufficient proof, showing the false nature of this question from the relation of heaven to earth. But those [arguments] that were adduced in *On Heaven and Earth* were taken from the nature of heaven itself. Since, then, we shall introduce here a demonstration from heaven's relation to the elements and to the place of our

71 See A., *De caelo et mundo* 2.3.10 (Ed. Colon. p.162,85-165,47).

72 Ibid.

habitation, this will be an instruction appropriate for this purpose, and for that reason it will be the more certain and clearer.

Taking up their position again, let us say then that they held that heaven necessarily makes a sound from the movement of friction and that animals' sense of hearing has become used to this sound and cannot discern it owing to habit, as we said above. Therefore, if what they say is true, then the animals' sense could get used to a sound equal to that and to one louder and to one softer. For it is necessary for these differences to exist in the sound of heaven because we experience that when something making a sound is nearer to hearing, then the sound becomes louder and is intensified, and if the same thing making a sound is more remote from hearing, then the sound is lessened and made to abate, and if it is at a middle distance between these two distances, namely, the nearest and the most remote, then the sound is perceived in a middling fashion. But we discover that heaven is related to us in this threefold distance through sensible geometric shapes, and for this reason vision attests to it. For the bodies that are on high, which are celestial bodies, sometimes approach nearer to us and sometimes withdraw farther away from us. And it cannot be said in response that our place of habitation is something imperceptible with respect to heaven's magnitude in the way that a point is with respect to the circumference [of a circle], and that for this reason it is not perceptible that the stars sometimes draw nearer to us and sometimes withdraw farther away from us. For that the earth is said to occupy the place of a point in respect to heaven's magnitude is said only in terms of the rise and fall of the [zodiacal] signs and of the size of the hemisphere, that is, because six signs are always above the earth and six below the earth, which would not be the case if the earth had a perceptible size in regard to this. But the earth has a perceptible size when compared to the spheres of the planets, on account of which the planets' diameters seem to be either larger or smaller, according to whether they enter our field of vision more or less, which would not be the case if the planets' altitude had no perceptible difference in relation to the earth.

Therefore, based on the assumption that these things are so, we say that, other things being equal, the sun and stars, the planets, and the moon are closer overhead when they are above our habitable zone in the north than when they look back obliquely upon our habitable zone, when they are in the south. But I still say that although one may get used to some sound, one is not used to a sound that is louder and softer than it, and for this reason it is perceptible. When, therefore, a person is born and has become used to the sound of heaven, as the opponent says, and for this reason does not perceive it, it is necessary that the sound of the stars be louder when they are in the northern signs and softer when they are in the southern signs, and a person ought to perceive this difference, since it is not one to which one is accustomed.

Moreover, on the supposition that the planets are borne in eccentric circles,⁷³ sometimes a longer part of the diameter will be above the zenith overhead, and then the star is higher and farther distant from overhead and ought to make a softer sound, whereas sometimes a shorter part of the diameter will be overhead, and then the star is lower and less distant and ought to sound louder, and this difference again will be perceptible. But the sound of one star still ought to be louder than another because its motion is nearer and faster than the others, and then because the moon among the celestial bodies approaches nearer the earth and moves more quickly by crossing the northern and southern signs in twenty-eight days, it ought to have a sound that is notably different compared to the other stars.

But as we have said concerning the planets, which are moved in eccentric orbits, so it is possible that we find a longer and shorter distance among the fixed stars which, although it is not caused by an eccentric orbit, is still caused by the fact that the star looks back either obliquely or directly upon the zenith directly overhead. In accord with this, a star is more distant from a position overhead when it is in the east or the west than when it is on the meridional line at the zenith overhead, and again in accord with this every star ought to sound different. But it will be the same for the sun, which is larger than all the planets and stars and for that reason will sound louder than all, according to them. For if they make the sun necessarily produce a sound from its motion, it will without a doubt sound louder when it is at midday at the zenith overhead and softer when it is at sunrise or sunset, looking back upon our heads obliquely with respect to the same season, because at sunrise and sunset the line that is between the sun and our heads is longer than the line that is between the sun and the zenith when it is at midday.

But from everything that has now been said, it is clear and plain that higher bodies do not make a sound. For if what has been said concerning the aforementioned assumptions is properly understood, the opinion of those who say that the stars make a sound when they revolve in orbit [*in circuitu*] is destroyed.

For we will now introduce a geometric illustration that demonstrates visibly and rationally that what they say cannot be true. I will draw a circle around a center point E representing the size of the entire earth, and I will delineate the place of our habitation on the arc of the earth's circle, which I will represent by point B. Then, I will draw another circle, whether eccentric or concentric, no matter which way I turn it, which will be the circle of the sun on a given day, designating its motion from the east through midday into the west, and I will draw three points on that circle: by G, I will represent sunrise, and I will represent

73 John of Sacrobosco defines an eccentric circle as one that divides the earth into equal parts but has its center outside the center of the earth. See *On the Sphere*, ch. 4, trans. Lynn Thorndike, in *A Source Book in Medieval Science*, ed. Edward Grant (Cambridge, MA: Harvard University Press, 1974), p. 449.

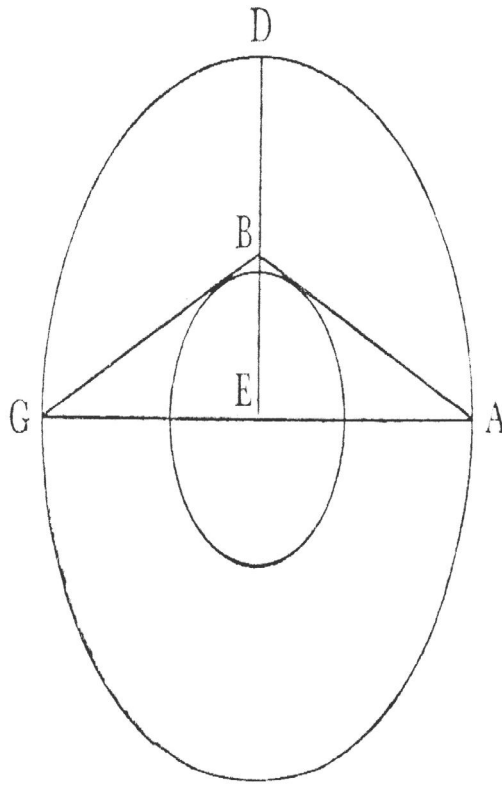


Figure 1

Source: Ed. Colon., p. 61

sunset by A, and the point of midday, when it is at the zenith directly overhead, I will represent with point D. Then I will continue with straight lines through the points by drawing line AG, which is the circle's diameter and crosses through the center, which is E, of each circle. Then I will also produce line AB and line GB, which are the lines denoting the distance that exists between the sun and the zenith overhead, when the sun is in the east or in the west. I will also extend line EB from the center, which line represents half the diameter of the earth, and I will continue the same line uninterrupted by drawing it as far as point D. Then line DB will be the measure of the sun's length from the zenith overhead, when the sun is at midday overhead. Such is the figure of this illustration. [Figure 1]

With the figure so arranged, I proclaim firmly that because the sun is larger than the rest of the stars and nearer to us than are some of those that are called planets, it makes a stronger sound than the other stars, and its sound is louder at midday when it is overhead than it is at sunrise or sunset, because it is clear

to us that lines GB and AB are longer than line BD. And the sun ought to make these differences in sound evident to our hearing every day. However, what we see and experience attests to the contrary of that.

But in the same way both the moon and the other stars produce a louder or softer sound owing to their greater or lesser proximity, and then at points G and A, which represent sunrise and sunset, they will sound softer, because they are more distant from us than at point D, when they are overhead and at the nearest distance to us, and hearing ought to perceive this. However, a mathematical proof reveals the opposite by means of the illustration that was introduced. For we have already presented those things that are necessary for the illustration's description. For we say that line AB and line GB are equal, by virtue of the fourth theorem of Euclid's first [book], which states that for every two triangles, where two sides of one are equal to two sides of the other and the angle [equal to] the angle, the base [of one triangle] will also be equal to the base [of the other] and the remaining angles [equal] to the remaining angles, and the whole triangle will be equal to the whole triangle.⁷⁴ For it follows that the two lines GE and EA are equal by virtue of the fact that they are from the same center point to the same circumference, so that each of them is one half the diameter of the same circle. But line EB, which is shared by both triangles, namely GEB and EBA, is equal to itself. Therefore, the two sides of the triangle GEB are equal to the two sides of triangle EBA. But angle BEA, which is at the center, is equal to angle BEG of the other triangle, which is also at the center, since each is a right angle. This is proved from the fact that line BE stands perpendicular at the center and makes a right angle on both sides. But every right angle is equal to every other right angle. Therefore, by virtue of the theorem introduced from Euclid, the base BA of triangle EBA is equal to base GB of triangle GEB, and this is what we said, namely, that the two lines GB and BA are equal.

With this established, we say that line GB is longer than line GE. But this is shown by the penultimate theorem of Euclid's first [book], which states: in every right triangle the square that is determined by the side of the triangle opposite to

74 Euclid, *Elementa* 1, theor. 4. Although Tummers remarks that Gerard of Cremona's translation of Anaritus' commentary on Euclid was the most important source that Albert employed in his own commentary on Euclid's *Elements of Geometry*, which Albert completed ca. 1260, and that the less reliable work of Adelard of Bath is of secondary importance for Albert (See P.M.J.E. Tummers, *Albertus (Magnus)' Commentaar op Euclides Elementen der Geometrie*, vol. 1 [Nijmegen, 1984], pp. 326-27), Professor Anthony Lo Bello has noted in a private communication that Albert's source here is in fact from the Adelardian tradition, and is contained in the "V-B" version of Euclid, found principally in two manuscripts, Biblioteca Apostolica Vaticana Reg. Lat. 1268 and Bonn Universitaetsbibliothek S 73. My special thanks to Professor Lo Bello for this information, and for useful corrections to my translation of the passages above treating Euclidian geometry.

the right angle considered in itself, is equal to the two squares that are described by the two remaining sides of the same triangle considered in themselves.⁷⁵ For there is a right triangle GEB, whose right angle is angle GEB, but the side opposite it⁷⁶ is line GB. Therefore, if that [line] is considered in itself, its square is equal to the two squares of the two lines GE and EB.⁷⁷ Therefore, its square is larger than the square of line GE alone considered in itself. But if the square is greater than the square, then the root is also greater than the root. However, the root is line GB; therefore line GB is greater than line GE is. And this is what we wanted to demonstrate.

With this established, we say that lines GE and ED are equal because they are from the center [of the circle] to the same circumference. Since, then, line GB is longer than line GE, it will also be longer than line ED. If line ED is longer than line BD, since BD will be part of the entire line ED, then line GB, which is longer than the whole of line ED, will be much longer than line BD. But line GB is the distance between us and the sun when it is in the east, and line BD is the distance between us and the sun when it is at midday; therefore, the distance between us and the sun is much greater when it is in the east than when it is at midday.

There is a method of demonstration similar to this to show that the sun's distance is greater from us when it is at sunset than when it is at midday. Therefore, it will sound perceptibly louder at midday than when it is in the east or west. However, this is false. Therefore, it remains that it is false that the sun, or some star, or the heaven makes a sound. And this is what we wished to demonstrate.

CHAPTER TWO

ON THE OPINION THAT STATES THAT THE SEA IS MOVED FROM PLACE TO PLACE

Because, however, there are no other properties in heaven besides those that were touched upon in *On Heaven and Earth*,⁷⁸ let us speak about the properties of the elements in order. Let us first touch upon the properties of water, because these are the more common [*communes*] and the better known among the properties of the elements. But there are three things in general [*in communi*] that ought to be investigated, the first of which is whether the sea is moved from place to place according to some of the celestial changes; the second

⁷⁵ Euclid, *Elementa* 1, theor. 46.

⁷⁶ I.e., opposite the right angle

⁷⁷ Ergo, the Pythagorean theorem, which states that the square of the hypotenuse of a right triangle is equal to the sum of the square of the other two sides.

⁷⁸ A., *De caelo et mundo* 1.1.5; 1.2.2; 1.3.4; 1.4; 2.1.1; 2.2 (Ed. Colon. pp. 14,28-16,39; 33,7-38,35; 61,61-65,45, 77,70-103,14, 104,7-106,18, 125,13-142,45).

will concern the inflow and outflow of the sea;⁷⁹ the third, however, is about the cause of a flood, whether it be a universal or a particular flood. And next we will inquire into the properties of air and then into the properties of fire, and last let us add things about the properties of earth in the final part, and whatever else ought to be investigated in general according to this purpose.

However, Aristotle's book only contains the first of these investigations in the parts of his book that have come down to us, and it is certain that other parts are missing and were not handed down to us, since without a doubt the other investigations that we enumerated have to be determined in this book from the principles already determined. For there arise here the elements' properties considered in themselves or produced in the elements from the motion of the sphere, and since those things that have been mentioned are produced in the elements from the motion of the sphere, these have to be determined here. For which reason, there must be a defect resulting from the truncation of Aristotle's first book, which is entitled *On the Causes of the Properties of the Elements*.

But when beginning to treat the first of these, we say that some of the naturalists [*physiologi*] who have great authority among the others said that the sea, both the Mediterranean and the Ocean, is moved from place to place and that that motion is initiated by the motion of the celestial sphere, which causes the motion of the sea from place to place. But they take the proof for their statement from the indication of the effect that they say is productive of a shift of the sea, which effect is the mountains and hills and valleys. For they say that the peaks of the highest mountains and the depths of the valleys were caused by the fact that the waves of the sea scraped away the earth on one side and made a valley there, and added it on another side, and a mountain's height was made there. However, the earth mixed together with the sea water made a sticky mud, and rock was made by first extracting such moisture from it, but second by the cold compressing the dispersed moisture, and this is why the mountains are rocky, as they say. But since there are mountains in many places, they say that the sea was moved from place to place. And since the cause for this change is not found in lower [bodies], it is necessary that it be caused by some movement of the celestial sphere.⁸⁰

One of them, however, reported an event that happened to him as evidence for this. For when he was digging a well and reached a level of clay in the earth's depth, he found there the rudder of a large ship, and he said that he knew from this that at one time the sea was in this place, although this was not in human memory, because the sea is only changed from place to place across long periods

79 I.e., incoming and outgoing tides

80 For a brief discussion of this theory of the movement of the waters and the formation of mountains and valleys in *On the Causes of the Properties of the Elements*, see Pierre Duhem, *Études sur Léonard de Vinci*, pp. 299-302. For Albert's refutation of the view attributed in the text to Ps. Aristotle, see also pp. 309-317.

of many men following one another, so that the length [of time] is not grasped in the memories of men.

Another cause for this is also the brevity of human life. For there are many causes of forgetfulness, which are touched on in the first part of Plato's *Timaeus*.⁸¹ One people overcomes another people and destroys it, and fires lay waste to the books recording the deeds of the ancients, and floods of fire and water destroy the memories that can exist from a written source so that those changes that exist only after many ages do not exist in our recollection.

This, then, is the position of the ancients concerning the change of the sea and the cause of its change, and this seems to be Plato's opinion in the *Timaeus*.⁸²

But in opposition to what they say, we state that they are themselves diminished by their views, since if it is necessary for the sea to be moved from place to place so that marine places sometimes become dry and dry places are sometimes made marine places, and deep places become receptacles for the seas, and the places of the seas are abandoned and there remain hollows and deep channels and high mountains next to these channels, and this is caused by the sphere, then it is necessary that in general it be caused by one of two movements of the sphere or by both of them. For in general there are two movements of the sphere, as we said in the second book of *On Heaven and Earth*.⁸³ One of these is from east to the west over the poles of the equator, and this is a diurnal movement, which all those [bodies] that are in heaven have once during a natural day, which is called *aplanes* motion.⁸⁴ However, the second motion is from the summer tropic to the winter tropic over the poles of the zodiacal circle [*circuli signorum*], which is a movement from north to south. All the stars have this motion, although they are moved more slowly or more quickly in that motion. Therefore, whether the sea's motion is caused by one of these two motions or by both, they ought to have provided demonstrations and observations for this by means of geometric illustrations of lines drawn out for sight, from which they might prove what

81 Plato, *Tim.* 22A-23C, translated by Chalcidius (ed. J.H. Waszink, pp. 13,18-15,9).

82 Ibid.

83 A., *De caelo et mundo* 2.1.6; 2.3.9 (Ed. Colon. p. 120,26 and p. 162,63).

84 For *aplanes* motion, see A., *De caelo et mundo* 2.3.7 and 9 (Ed. Colon. p. 157,73 and 162,65). At *De animalibus* 20.2.2.71 (ed. H. Stadler, p. 1310) A. explains that *planes* motion is an erratic motion from west to east over the pole, and *aplanes* motion moves from east to west in a diurnal fashion. See *De gen. et corr.* 2.3.5 (Ed. Colon. p. 205,80). Cf. Macrobius, *Commentarii in Somnium Scipionis* 1.6.18; 1.11.6, ed. J. Willis, 2nd ed. (Leipzig: Teubner, 1971), pp. 21 and 46 where *aplanes* is defined as "immovable" and the earth—a fixed, immovable body—is described as *aplanes*. But Macrobius also identifies as "Platonists", however, those who hold more in accord with reason the view that it is the whole of the sky that is called *aplanes* (*Somnium Scipionis* 1.11.10, p. 47), and that this sphere revolves from east to west in a diurnal motion (*Somnium Scipionis* 2.4.8, p. 108).

they were saying. And they of course do not do this, but they only profess with a simple assertion that all that occurs on earth and in lower [bodies] occurs on account of the motion of higher bodies, because this is the noble element that alone among all bodies moves with a perpetual motion of its own, and this is why it is the cause for all the accidents of lower ones. And they introduce many of their effects, as they say that the flood that was upon the earth under Pyrrha and Deucalion⁸⁵ was only owing to the great conjunction [*coniunctio magna*] of the seven planets in the sign of Pisces, in which there is an inundation of waters, and that the pestilential wind that killed people everywhere in the land of Hadramot⁸⁶ was on account of the great conjunction of the planets in the sign of Gemini, which is an airy sign causing corruptions of the air. But the cause of the plague that occurred in the land of Iamen,⁸⁷ a region of the Indies, was in these same planets in the earthy sign of Virgo, which causes and produces corruptions of the earth.

In like manner, however, they discuss the other effects that result from the conjunction of the stars, of which we will make mention below. A perfect understanding of these matters belongs to the book *On the Major Accidents of the World*, which is subsumed under astronomy.⁸⁸

But they also introduce the fact that we see that the sun produces heat in lower [bodies] and we see that the moon changes many bodies, because pregnancies and times of birth and the ripening of things and their completions and their yields [*augmenta*], which are increased, and similarly the expansions of rivers in particular, follow the course, disposition, and size of the moon.

In like manner, however, they introduce the fact that when the moon rises during the day or the night above the horizon of some region, it causes a surge out of the sea⁸⁹ to the extent that rivers entering the sea in those places flood and flow backward against their own course. However, when it divides the heaven of that region in half, that is, when it touches the zenith overhead, then it flows into the sea, and the rivers do not flood but flow in a natural course into the sea. And when the moon sets from the horizon of that region, the sea water begins to surge out again, and the rivers begin to flood until the moon touches the turning point [*cardine*] of the lower hemisphere. This is when it is in the lower

85 On Deucalion and Pyrrha, see *infra* 1.2.9, with note note (p. 71, n. 164). See A., *Metaph.* (Ed. Colon. p. 23,54, with note).

86 Hadramot = Hadramawt. The southern part of the Arabian peninsula. See Vodraska (DCPE, pp. 292-93); see A. F. L. Beeston, "Hadramawt," *Encyclopaedia of Islam*, eds. P. Bearman, Th. Bianquis, C.E. Bosworth, E. van Donzel and W.P. Heinrichs (Brill, 2007), Brill Online. Oxford University libraries. 09 August 2007.

87 For Iamen, an area roughly identical to Yemen, see *supra* 1.1.5 (p. 35 and n. 64); see Vodraska (DCPE, p. 293).

88 A work Albert planned to write but evidently never completed.

89 I.e., a tide.

hemisphere at the point opposite the zenith overhead, and at that time the water begins again to diminish, just as it had begun to increase when the moon is on the rise, and visual inspection discovers that such increases and decreases of the sea follow the orbit of the moon.

The other planets, however, participate in the same way with the sun in their operations. For they draw off moisture by their light and from its heat in the south, when they decline to the southern signs, and this is observable. For since the Nile comes into Egypt from the south, the Nile floods more when the planets are in the south toward Capricorn than when they are not there. For the flooding of the Nile is sometimes greater and sometimes less by virtue of the fact that there are more or fewer of the wandering stars in the south.⁹⁰ And certain stars, like Venus and the moon, produce these floods more than the others that are drier than they. For when the sun is in the north and the wandering stars are in the south, then, owing to the absence of a heat that draws off a lot of moisture, the rains in the south are cut off, and the Nile's flooding is reduced. However, when the sun is in the south and the planets are there with it, then a good deal of rain occurs on account of the heat that draws off a lot of moisture, and then a great flooding of the Nile results. For the Nile floods once when the sun is in Cancer, and when the sun is under Capricorn it floods again, and then going out of its riverbed, the Nile irrigates the crops of the Egyptians. And we will touch on the cause for this below.

In the same way, however, when the moon is full, because at that time it has a lot of the sun's light drawing off the humors, the expansions of the rivers and the expansions of the sea are increased, and the flooding becomes more intense than when it is not full, for the reason that we mentioned. And these things are indeed evident to the senses.

However, when the stars rise in various ways over the seven climes, they are discovered to be the causes of years of barrenness or fruitfulness, insofar as sages of the stars report that when the two stars that are called "heavy" owing to the slowness of their motion, namely, Saturn and Jupiter, are in conjunction at one of the points of a [zodiacal] sign in heaven, then mortality and depopulation occurs, such that kingdoms are emptied. And this is wont to occur when they are conjoined at the change of triplicity to triplicity.⁹¹

For the signs of the zodiac—twelve in number—have four triplicities, that is, four groups of three zodiacal signs that share one complexion, as Aries, Leo, and Sagittarius are fiery, hot, and dry signs, but Taurus, Virgo, and Capricorn are earthy, cold, and dry signs, while Cancer, Scorpio, and Pisces are watery, cold,

90 The "wandering stars" are the seven planets in antique cosmology, whose movements were clearly perceptible.

91 A triplicity consists of the three signs, evenly spaced, in which successive conjunctions occur, as Albert explains just below.

and moist signs, and Gemini, Libra and Aquarius are airy, hot, and moist signs.⁹² And it has been proved that the two stars Saturn and Jupiter are conjoined by their mean motion in one triplicity twelve times before they are conjoined in another sign. For they are conjoined once over twenty years, less one eighth part of a year, and their conjunction occurs over the arc that is in the ninth sign from the first conjunction, with the addition [*appositio*] of two and one-half degrees. Twelve times two and one-half degrees, however, produce thirty degrees, and this is why their thirteenth conjunction is outside the triplicity in the tenth sign. For the ninth sign, reckoned from any sign in the zodiac, belongs to the same triplicity with it, but the tenth belongs to another. However, twelve times twenty produces two hundred and forty years, and this is why over two hundred and forty years these stars are always conjoined in one triplicity in the twentieth of twenty years.⁹³ However, when they change triplicity, then the astronomers say that a new power is infused in lower [bodies] from heaven, and ancient places of habitation are destroyed and new ones begin, as is demonstrated well in the book *On the Great Accidents of the Air*.⁹⁴

We have, however, passed over many things concerning the effects of the higher [bodies] in order to avoid prolixity. For it has been adequately demonstrated from these remarks that those effects that exist in lower [bodies] are caused by the motions of the higher ones.⁹⁵ It is seen, therefore, from the parallel that the sea's movement is caused by the motions of the higher bodies.

CHAPTER THREE

ON THE REFUTATION OF THE VIEW THAT SAYS THAT THE SEA IS MOVED FROM PLACE TO PLACE

Opposing them, however, we state to the contrary that, if the sea were moved from place to place, then its movement would without any doubt be caused by one of the movements of higher [bodies]. But we state that it is not continuously moved from place to place, and for this reason this is not caused by movements of the higher bodies.

For if it were moved, either it would follow the sphere of the moon in its movement, by which the moon is moved through the signs, which is completed in twenty-eight days, and thus the sea would be moved from place to place every

92 See Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis de Sacrobosco*, lectio 4, in *The Sphere of Sacrobosco and its Commentators*, ed. Lynn Thorndike (Chicago: University of Chicago Press, 1949) p. 167,3-17.

93 That is, successive conjunctions of Saturn and Jupiter occur about every twenty years. A *coniunctio maior* or Greater Conjunction takes place every two hundred and forty years.

94 Again, a book that Albert appears never to have written.

95 See A., *De caelo et mundo* 2.2.5 (Ed. Colon. p. 137,3-5).

twenty-eight days. But then agriculture would be entirely destroyed, because before it could be brought to harvest, the sea would pour forth its waters. In the same way, however, generation too would be brought to naught on earth because of too little moisture.⁹⁶

Or it would be said to occur on account of the motion of Mercury or Venus, which have almost equal orbits that are nearly completed in ten months, and then the sea would be moved from place to place every ten months.

Or it would result from the movement of the sun, and then it would occur once each year, since the sun completes its orbit once each year.

Or its cause will be the operation of Mars and its motion, and then it occurs every eighteen months, since Mars almost completes its orbit in that much time.⁹⁷

Or the cause for this is the motion of Jupiter and its movement, which it makes once every twelve years, and then the sea will be moved from place to place by [its] complete orbit of the earth every twelve years.

Or its cause is the motion of Saturn through its orbit, and then that occurs every thirty years.

Or it is caused by the simple conjunction of the two “heavy” stars,⁹⁸ which are Saturn and Jupiter, and then it occurs every twenty years, since Saturn and Jupiter are in conjunction in one sign once every twenty years, as we said above.

Or it is caused by the conjunction of Saturn and Jupiter with the change of the triplicity, and then it will happen that it occurs every two hundred and forty years, as we explained above.

Or this happens on account of the motion that the authors of the *Altasimet* propose, that is, [the motion] of the images of the zodiacal signs; they say that there is the motion of the advance and retreat of the beginning of Aries and Libra in higher [bodies].⁹⁹ For they say that the beginning of Aries sometimes retreats from the equator into the south and sometimes into the north upon an orbit whose diameter the ancients said has fifteen degrees, of which seven are

96 That is, if the sea were to move entirely in one direction, it would leave other areas of habitation devoid of its moisture.

97 See A., *De caelo et mundo* 1.3.5 (Ed. Colon. p. 66,60-67,50).

98 For a definition of Saturn and Jupiter as “heavy” stars, see *supra* 1.2.2 (p. 46).

99 “The authors of the *Altasimet*”: likely a reference to the authors or masters of the *al-tilasmāt*, treating astrological talismans. Vodraska identifies this motion with the doctrine of trepidation mentioned by Theon of Alexandria (although modified by medieval astrologers; see *DCPE*, p. 268). According to this doctrine the vernal and autumnal equinoctial points did not stay fixed, but moved in small circles, in motions referred to as trepidation or accessus and recessus. Charles Burnett has pointed out that the twelfth-century translator Hermann of Carinthia seems also to have been acquainted with astronomical traditions stemming from the masters of *al-tilasmāt*, and that these also advocated a theory of trepidation. See Hermann of Carinthia, *De Essentiis*, ed. and trans. Charles Burnett (Leiden: E.J. Brill, 1982), p. 30.

in a motion advancing to us from the equator toward the north and eight are in a motion retreating from us toward the south. According to them the center of this small orbit, over which the beginning of Aries is moved, is not on the equator but is a half degree to the south beside the equator. But Thebit ben Chore¹⁰⁰ has now verified this motion better and said that the advance and retreat are equal and proposed that the center is on the equator and that the half diameter is almost nine degrees and that the motion of its orbit through one degree occurs in eighty years. Albategni and the experts on the stars agree with this, but Ptolemy does not mention this motion.¹⁰¹ And then this occurrence ought to be completed in six hundred and forty years. Therefore, over such a long period of time the sea ought to traverse all the places of the earth. But this is not true, because many places were built two or three thousand years ago, and the sea has never been there.

Or this is caused by the motion of the fixed stars, which are perceived to move one degree in every hundred years and to complete an entire orbit in thirty-six thousand years.¹⁰² And then in one hundred years the sea ought to recede one degree from the earth, and another degree again in another hundred years, until it travels across the entire circle of the earth, as the stars travel through the circle of heaven.¹⁰³ And this is the furthest and slowest motion, on which the authors of the *Alictisal*,¹⁰⁴ who make images according to the courses of the stars, rely.

And we do not find that the sea follows that motion because we have found by a geometrical proof, by means of measurements of the cosmos [*cosmimetriae*], that the entire globe of the earth is only twenty-four thousand miles, and the sea would have to complete a revolution of the earth in thirty-six thousand years.

100 I.e., the Arab astronomer Thābit b. Qurra b. Mirwān al-Harrānī Abu'l-Hassan (834-901).

101 Albategni, also identified as Azerbeel the Spaniard in the *Speculum astronomiae*, c. 2, ed. Paola Zambelli, Boston Studies in the Philosophy of Science 135 (Dordrecht and Boston: Kluwer Academic Publishers, 1992), p. 212, 13. This is Muhammad b. Jābir b. Sinān al-Battānī al-Harrānī Abū Abd Allāh (ca. 858-929). See Al-Bitrūjī, *De motibus celorum* in *De motibus celorum: Critical Edition of Michael Scot's Latin Translation*, 10, 16-17, ed. Francis J. Carmody (Berkeley and Los Angeles: University of California Press, 1952); A., *De caelo et mundo* 2.3.11 (Ed. Colon. p. 166,47 with note).

102 Unlike the wandering stars mentioned above, the fixed stars are those whose movement is so gradual and slow that it cannot be established by sight, but can only be calculated over very long periods of time.

103 See A., *De caelo et mundo* 1.4.1; 2.3.11 (Ed. Colon. p. 79,27 and p. 166,44).

104 An Arabic loan word (properly, *al-ittisāl*) referring to the conjunctions of the planets. See Garland Cannon, *The Arabic Contributions to the English Language: An Historical Dictionary* (Wiesbaden: Harrassowitz Verlag, 1994), p. 127. Given the context, however, it seems that Albert may have meant once more the "authors of the *Altasimet*," for which see p. 48, n. 99.

Therefore, in one hundred years, it would have to cross a noticeable distance, so that it would approach more and more near to cities that are at the sea, like the city of Arixin,¹⁰⁵ which is on the sea, and to the city of Medina and to the city that is called Merendyb,¹⁰⁶ and to Venice and to Pisa and to Iacinas¹⁰⁷ and to the other maritime cities. Or it would have to recede from them gradually. In the same way, however, this would have to occur at the cities of Alepila¹⁰⁸ and Gamen,¹⁰⁹ which are on the sea of Iamen. And the same would have to happen in Egypt and in Alexandria, which are between the Red Sea and the Great Western Sea, which the Arabs call *Scemy*.¹¹⁰ But the same thing would have to occur near Rome and Byzantium, that is, Constantinople, and near many other cities that would take too long to recount. However, we do not see anything like this occurring in the sea concerning the sea's approach or retreat, nor has anything reached us in the past from the chronicles of those who wrote about the deeds of kings and the changes of the earth, nor has any of the wise philosophers who spoke about the nature of the sea and the rains written anything resembling this concerning the sea's advance or retreat toward any city, other than that it is as it is today.

If, however, someone should introduce an objection concerning the retreat of the English sea, which is a part of the Ocean, from the city that formerly was known as Tungra Octavia¹¹¹ in which we see with [our] eyes that the sea has retreated a

105 That is, Arin/Arim/Aren, the central Indian city of Udidjayn—see the *Encyclopedia of Islam*, ed. H. A. R. Gibb (Leiden: Brill, 1999), 10: 778b—treated as an ideal rather than real city, which Muslim geographers located at the center of the world at zero longitude. One finds the city over the center of the equator in an illustration from a twelfth or thirteenth-century manuscript of a treatise entitled *De recta imaginatione spere*, usually ascribed to the ninth-century Thâbit b. Qurra. See John E. Murdoch, *Album of Science: Antiquity and the Middle Ages* (New York: Charles Scribner's Sons, 1984), p. 142, ill. 130. In the early twelfth century Petrus Alfonsi includes an extensive discussion of Arin in his *Dialogue Against the Jews*, trans. Irvén M. Resnick, *Fathers of the Church, Medieval Continuation 8* (Washington D.C.: The Catholic University of America Press, 2006), pp. 55-63. See also André Miquel, *La Géographie humaine du monde Musulman jusqu'au milieu du 11^e siècle. Géographie arabe et représentation du monde la terre et l'étranger* (4 vols.; Paris: Mouton & Co., 1967-88), 2: 486-7.

106 Vodraska's edition (*DCPE*, p. 154) has Serendib for Merendyb and identifies Serendib as the island of Ceylon (Sri Lanka after 1972) to the south-east of India (*DCPE*, p. 296). Merendyb is not identified.

107 Iacinas has not been identified.

108 I.e., the city of Aleppo, Syria.

109 Gamen has not been identified, other than to say that it is on the sea of Iamen/Yemen.

110 Vodraska (*DCPE*, p. 297) identifies *Scemi* as, literally, the 'Sea of Syria', i.e., the Mediterranean Sea.

111 Perhaps to be identified with the modern Belgian city of Tongres. A. identifies it at *De nat. loci* 3.2 (Ed. Colon. p. 33, 31) as once a city—but in his day more a small

great distance in a short time and still retreats without interruption from a city in Flanders called Bruges, we shall state that this retreat is neither continuous nor is it caused by the [celestial] sphere, but rather that it occurs accidentally [*per accidens*]. For if it occurred from the [celestial] sphere, then necessarily it would occur in every sea, both in the Ocean and in the Mediterranean. Now, however, it occurs accidentally, namely, because levies were increased in number in the port and were raised up above the waves of the sea, and because of them the path to approach those cities is blocked to the sea, and for this reason it is drawn back. And an indication of this is that the sea in those lands is confined to its bed by means of the erection of the levies on its shores, and the people of this country obtain a great deal of land by pushing the sea away from them in this manner, and this is why its retreat from these places is not natural but accidental.

Still, however, someone will perhaps raise an objection based on what will be determined in *On Meteors*,¹¹² where it will be shown that Egypt was under water and that there is no part of the earth that was not wet at one time and at another time dry. For if these things are true, then it seems that the sea is moved from place to place over the circle of the earth. But the movement of the sea is not established from what will be said in *On Meteors*, but rather that sometimes places grow damp and sometimes they are dried out from other causes, which are the causes of particular or universal floods, which we will discuss below.

But what they say about the mountains and valleys, namely, that these are caused by violent sea storms, we will show to be false in the following book, and we will determine the causes of mountains and valleys in the following book and in part in the book *On Meteors*.¹¹³

Also to what they said about the person digging a well, who found an oar,¹¹⁴ one must reply that the oar was deposited there a long time ago and that the ground was built up over it and that it was preserved from putrefaction by the ground's coldness, or that the sea was there at some time and retreated from that place at some time as the result of an accidental cause. For we have also seen in Cologne that deep pits are made and at their bottom paving stones of marvelous design and beauty were found, and it is agreed that ancient peoples produced them there and that the ground was built up over them after the buildings fell to ruin.¹¹⁵

Now it is, therefore, clear from the things we have said in the foregoing that the premise [*intentio*] of the one who said that the sea is moved from place to place on the earth has been destroyed, and the error of all of those who have

village—near to Liège.

112 A., *Meteora* 2.2.15 (Ed. Colon. p. 78,42-45).

113 *Infra* 1.2.2, referring to a ship's rudder (p.43); A., *Meteora* 3.2.18 (Ed. Colon. 147-48).

114 *Supra* 2.2.4-5 (pp. 115-18).

115 A. composed this work, it is believed, while in Cologne.

thought this is readily apparent. It belongs to the study of the book *On Meteors* to determine the place of the sea.¹¹⁶

CHAPTER FOUR

AND THIS IS A DIGRESSION EXPLAINING THE EIGHT THINGS THAT SHOULD BE KNOWN IN ADVANCE IN ORDER TO KNOW THE RISE AND FALL OF THE SEA¹¹⁷

When treating the rise and fall of the sea, it is necessary that we set out in advance everything that contributes to understanding it. One of these things, however, is that although in general all the planets have an effect on lower bodies, still the sun and the moon are the principal planets whose properties and powers lower bodies follow, on account of three causes. The first of these is the amount of their light. For the other planets are luminous bodies and move lower bodies by their motion and light, but they do not project noticeable rays and shadows upon lower bodies. But the luminous bodies, that are the sun and moon, move by their motion and light and rays, and for this reason they also cast shadows when some opaque body blocks their rays, and for this reason their influence is very strong on lower bodies. Another cause, however, is their location among the planets, since although the moon is smaller in size than all the planets but one, it is nevertheless nearer to lower bodies and approaches their natures more. This is the reason that it changes them, and on account of this the critical days [*cretici dies*]¹¹⁸ are numbered according to the

116 A., *Meteora* 2.3.10 (Ed. Colon. pp. 92-93).

117 See Albumasar's *Introductorium maior*, 3.4-8 for a lengthy account on tides. A Latin translation of this work was provided by John of Seville, and revised by Gerard of Cremona. For the text, see *Liber Introductorii maioris ad scientiam judiciorum astrorum*, ed. Richard Lemay, vol. 5[2], pp. 102-131. The motion of the tides was also a topic of great interest to Albert's younger contemporary, Robert Grosseteste, to whom is attributed a treatise entitled *Questio de fluxu et refluxu maris*, written before 1235 A.D. This latter treatise, borrowing heavily from Albumasar, also addresses the eight causes at *De fluxu* 2. For Grosseteste's text, see Richard Dales, "The Text of Robert Grosseteste's *Questio de fluxu et refluxu maris* with an English Translation," *Isis* 57.4(1966): 455-72; for a discussion of the text and its sources, see Edgar S. Laird, "Robert Grosseteste, Albumasar, and Medieval Tidal Theory," *Isis* 81.4(1990): 684-94. Given Albert's reference to Albumasar, it is not surprising to find a number of similarities between his treatment and Grosseteste's.

118 For *cretici dies* see also *infra*, 1.2.7 (p. 66). "Critical days" are days on which an illness was perceived to undergo a sudden, violent change that either implies recovery or death. They are, then, especially useful in determining a prognosis. Galen's *De ceticis diebus*, circulating in Latin translation in the second half of the thirteenth century, emphasized the importance of such days for medical judgment. So too did

moon, and the moon is called the queen of heaven,¹¹⁹ because it rules over the fluids [*umiditates*] of lower bodies. And this is why metals and plants and animals' members and especially the eyes, in whose composition water's nature abounds, receive the greatest alterations and increases and diminutions according to the moon. But the sun is positioned in the middle of the planets by glorious God and is like the heart that distributes powers everywhere,¹²⁰ and although it is farther away than some planets, it is nonetheless greater than them all in terms of size and light, and this is why it moves and transforms lower bodies most powerfully. The specific properties and powers [*virtutes*] of the qualities of these luminaries are the third cause. For because the moon has an earthy and watery property, it has to move all things in which water and earth dominate by virtue of its connaturality.¹²¹ But because the sun is the source of vivifying heat,¹²² it causes the humors to bubble up, because moisture is naturally drawn to the heat raising it up and becomes steam. For this reason the ancient Egyptians said that the sun attracted moisture as the nutriment for all the heavenly bodies.¹²³ This is then one of those things that it is necessary for us to presuppose.

A second, however, is that there is a great deal of diversity among rivers and seas. And there is found a sea that stands still that never rises or falls.¹²⁴ A sea is also found that rises from the beginning phase of the moon until the full moon and falls from the full moon, which by some is called the interlunary interval¹²⁵ and which the Arabs call *almuhac*, until the complete absence of the moon, producing in a single month only one rise and one fall. Some seas, however, rise twice each day and fall twice. For the Pisan Sea stands still and neither rises nor falls, whereas the sea that is the Persian Gulf and the Sea of India and the seas of all the islands that are in between them, and the sea that is between

the popular late thirteenth-century *Aggregationes de Crisi et Creticis Diebus: Medieval Prognosis and Astrology*, ed. C. O'Boyle (Cambridge: Wellcome Unit, 1991), which relied heavily on Galen's work.

119 On the moon as the queen of heaven see also A., *De caelo et mundo* 2.3.15 (Ed. Colon. p. 178,14); *De animalibus* 18.2.8.90 (ed. H. Stadler p. 1238); and *De veg.* 7.1.9 (ed. C. Jessen p. 619).

120 See A., *De caelo et mundo* 2.3.5 (Ed. Colon. p. 153,24); *De animalibus* 1.1.5.73 (ed. H. Stadler pp. 27-28).

121 Connaturality implies participation in the same sort of nature.

122 See A., *De caelo et mundo* 2.3.6 (Ed. Colon. p. 154,67).

123 See A., *De caelo et mundo* 1.1.11 (Ed. Colon. p. 28,40-48); 2.2.5 (Ed. Colon. p. 135,55).

124 "Rises or falls": *accedit* and *recedit*. Previously we had translated these terms as "advances" and "withdraws" or "retreats" but here A. seems more clearly to describe tidal movements which cause the sea to rise or fall.

125 That is, the time of the new moon.

Constantinople and Venice, and in the north the Ocean channel¹²⁶ [*gumphus*] that lies between England and Flanders and Germany, and all seas like these, likewise rise and fall twice in a natural day. Also they differ a great deal in terms of the strength of their rise and fall.

But a third thing that must be noted in advance is that a rise and fall occurs in the sea only when the moon touches some circle of the hemisphere of that sea that is rising and falling. There are, however, four arcs of the two hemispheric circles, and when the moon touches them, a change immediately begins to appear in the sea. For there are two circles of the hemisphere: one is the horizon and the other is the meridian.¹²⁷ But the horizon has two arcs, one toward a point of the east and the other toward a point of the west. In like manner, however, the meridian also has two arcs, one of course in the middle of heaven above the zenith directly overhead the region, and this arc is called the angle of the middle of heaven, whereas the other has the zenith directly overhead on the opposite side directly under the feet of the region, and it is called the angle of mid-night or the angle of the middle of the earth. But when the moon attains the angle of the eastern hemisphere in some region in which there is a sea, the sea begins to rise, and when the moon attains the arc that is toward the angle of the middle of heaven, the sea begins to fall. But when the moon again attains the arc that is toward the angle of the west, the sea begins to rise, and when it comes to the arc of the angle of the middle of the earth, it then begins to fall.

But a fourth thing that we ought to present in advance follows from this. For since the earth is round and the moon is moved in a round circle, it follows necessarily that the angles of the hemisphere and of one region of the sea are not the angles of the hemisphere and of the other region of the sea. And if these regions are far distant from each other, it often happens that if the times for the rise and fall of the sea are calculated, that at the same hour when the sea rises in one region, it falls in the other, and that the time for the beginning of the rise in one region is the time for the beginning of the fall in the other, or that the beginning of the fall in one region is the middle of the fall or its end in another. And this necessarily varies in an infinite number of ways. And this occurs owing to the difference between east and west and the angle of the middle of heaven and the angle of mid-night in diverse regions, especially with respect to the earth's

126 "Channel" = *gumphus*, sometimes a right-angled hook, even a fish hook, and often suggesting an ocean bay or inlet. This reference here seems to be to the English channel, extending into the North Sea.

127 The meridian is a circle that passes through the poles of the world such that, whenever the sun reaches the meridian, it is noon to the observer. The horizon is a circle that divides lower and upper hemispheres, whose pole is always the zenith overhead. See John of Sacrobosco, *On the Sphere*, ch. 2, trans. Lynn Thorndike, in *A Source Book in Medieval Science*, ed. Edward Grant (Cambridge, MA: Harvard University Press, 1974), p. 448.

longitude, because longitude necessarily alters all the angles mentioned more than does the regions' latitude.

But the fifth thing is almost like this, namely, that it is necessary for the rise and fall of the sea to differ at the bottom of the sea far from the shores and on the shores themselves, because since a distance of five hundred *stadia*¹²⁸ perceptibly alters the circles and angles of the hemisphere, it is necessary that the sea's rise be perceived more quickly at the bottom of the sea toward the east than on the shore. But it is still only perceived at the bottom of the sea by the sea's elevation from the bottom, which ocean-going sailors call a sea swell. For the water is then raised from the bottom by the moon, and it swells and produces storms that are sometimes dangerous for those sailing so that marine monsters are raised to the surface of the sea.¹²⁹ But the water that is lifted up spills over the other sea water, and it does not have another rise and fall on the bottom. But on the shores it spills over the shores and flows up onto the earth beyond its shore.

The sixth is that it is necessary for the same reason that the inward surge and return of the sea alternate on its two very distant shores, one of which is to the east and the other to the west.

However, the seventh is that sometimes there is a sea swell that is a source of the rise and fall, and still no rise and fall is perceived on the shore because the shores are very wide in comparison to the water's depth, and they are not deep, nor do they hold a lot of water. And then a rise is not perceived from the water's advance upon the shores, but only from the water's greater depth on the shores, because the shores are adequate to contain the water poured out upon them by the sea swell.

Moreover, the eighth thing that it is necessary to know in advance is that winds are a sign preceding a sea swell and its rise which, if they are very strong, signify that the sea's rise will be strong, and if they are weak, they signify that the rise will be weak. And when the winds cease, it is a sign of the sea's fall. These, then, are the things that must be presented in advance.

CHAPTER FIVE

AND THIS IS A DIGRESSION SHOWING THE TRUE CAUSE OF THE SEA'S RISE IN GENERAL AND EXCLUDING THE ERRORS THAT ARE OPPOSED TO THIS

With these things set forth, however, it is necessary to determine the cause for the seas' rise and its diversity. We say then that the cause for its rise and fall results from three simultaneous concurrent factors, of which one stems from the disposition of the water that rises and falls,

128 Five hundred stadia = sixty-two miles.

129 See A., *De animalibus* 24.1.11(18) (ed. H. Stadler p. 1521)

and the second stems from the disposition of the locale in which it rises and falls, but the third stems from the position of the moon that moves the water that rises and falls.

And sea water's disposition is of course that it is thick and salty with an earthy admixture, standing still in one place for a long time, which is why it is fetid, and that there is a great deal [of water] at the same time in terms of depth and breadth. And because it is thick, it retains powerfully and for a long time the vapor that is generated in it. From its saltiness it has a natural heat that causes the vapor found in its depth to be easily raised up. And because it is earthy, it contributes to the coarseness and thickness of this vapor that is raised up in it from its bottom. And because it is standing still, not moved, it causes the sun's heat to remain within it, which heat corrupts its water and changes it into brackishness and stench. But the fact that there is a great deal of it at the same time causes it to bubble for a long time when the vapor moves it before the vapor that is enclosed within it gradually escapes from it, and this causes it to have two motions. One of these motions is from its bottom to the surface, which is called the sea's "boiling" and disturbance. The second is an overflowing [*superfusio*],¹³⁰ which is a motion on its surface when water pours over other water that is near to it, and at that time it breathes forth its stench along with the vapor and is perceived. For this reason one of the indicators by which those on the deep know that the water of the sea will bubble up nearby is its stench, which begins to be diffused with the subtle vapor that is released from it first before it is moved. And a second indicator is the wind that arises when the vapor begins to be thicker and stronger, and then the sea boils up immediately after that. And by these same indicators those who live near the seashore know that it will rise nearby and will be poured out upon their shore.

But a cause that results from place is that places that are receptacles and shells, as it were, for the sea are hard¹³¹ and long and surrounded by mountains in many instances and that many mountains and rocky outgrowths are in the sea itself in different places. For such places gather up a strong windy vapor and retain it, because places hold the vapor's firmness on account of the hardness of the place. For soft places quickly release and fail to contain the vapor generated in them, but they emit it gradually as it is generated in them, because in themselves [*per se*] they lie open at all times. But solid places are only opened when some celestial body moves them violently, as it were, and then they are opened by the impact, and at the same time they emit the vapor that has been retained and gathered up within them. But from the fact that they are long, the vapor in them is increased and compressed, and from the fact that they are associated with mountains and hills, they are suitable receptacles for the vapors and are capable of generating a

130 "Overflowing": A. seems to mean wave action.

131 "Hard" = *dura*, which also implies containing a large amount of earthy matter.

great deal of thick vapor. For this reason, the water lying on mountains always seems to be moved with curling waves, owing to the motion of the vapor that has been lifted up from the bottom, which moves the water.

A third cause, however, which has to come together with these, is the position of the moon. For when the moon touches the circle of the hemisphere, then the presence of its body and light is first in the east, and its ascent is not completed until it touches the meridian circle of the same hemisphere. And when the light's presence is in the quadrant between the point of the east and the meridian, then the light's presence reaches the point of the west with a direct ray and confers the powers of its light upon them so that every degree through which it ascends from the angle of the east to the angle of the middle of heaven sends forth a ray and its powers upon every degree opposite it in the quadrant, through which it descends from the angle of the west to the angle of the middle of the earth. And for this reason the western quadrant moves the sea just as the eastern quadrant does. And this is the cause from the side of the moon that moves of why it moves the sea to rise twice, that is, when it ascends from the east to mid-heaven and when it descends from the west to the angle of the middle of the earth. However, when it is retreating from the angle of mid-heaven, leaving behind the point of the meridian, then its power is diminished over the sea's hemisphere, and its rays that are directed into the deep are reflected from its surface, and they do not move the sea's place, but look back upon the water from an oblique aspect, and the vapor has already escaped that cast the water out from its place, and then the water returns to its place not through the moon, but through its own nature, and this is called the fall of the sea. But the cause for its return is the same when the moon retreats from the angle of the middle of the earth, since its rays coming from that angle are not fixed over the sea, but rather cut its water obliquely, and they are not directed to its bottom, and for a second time the vapor raising it has already been released, when the moon was in the point of the west, and for this reason the water returns at that time once again to its place by a natural motion.

The effect of the moon, however, on the moist element is wondrous, since it draws it and moves it from a distance, as a magnet moves iron. This is because the moon is itself the first cause of the watery moisture, as we said in the book *On Heaven and Earth*.¹³² And because it is, as it were, a second sun, since it receives light from the sun, it causes the wind that is at the bottom of the sea to evaporate. And this occurs as the result of three causes, of which one has already been mentioned, that is, that the moon's light is received from the sun, and by its heat it rarifies the thick vapor standing in the sea, which, once it has been rarified, seeks to expand and pushes the water up from the bottom. A second cause is the moon's own nature, which moves the moist element. This is why when water meets it, it becomes warm and moves the vapor with its motion; this

132 A., *De caelo et mundo* 1.1.11 (Ed. Colon. p. 29,66-67).

vapor, seeking to be released, expands and pushes up the water. A third cause is the position of the moon on the circle of the hemisphere. For then it ascends from the eastern quadrant, and for this reason the water is raised up with it and is pushed up by the moon's power. And it acts similarly in the western quadrant, because these quadrants have similar powers [*virtutes*] owing to the cause that we mentioned. In sum, these are the causes for the sea's rise and fall.

But an indication of this is that when the moon remains over the earth longer than it does under the earth, the time for the first rise and fall is longer than for the second. Conversely, when it remains longer under the earth than over it, then the opposite occurs. Similarly, if it delays longer in the eastern quadrant than in the western quadrant, then the time for the first rise is longer than for the second rise, and the judgment is the same for the time of the rise compared to the time for the fall.

But a proof for this is provided by another indicator, namely, that the rise anticipates the time according to the motion of the moon on a deferent circle.¹³³ For when it is full, it rises above the hemisphere at the time of sunset, and the motion of the sea water follows after it. However, when it wanes from its fullness across thirteen degrees, which represent the movement of the moon in one day, then it rises over the hemisphere on the next day almost an hour after sunrise, and then the motion of the water follows the moon at a different hour from the preceding day. Besides, the astronomers say that one who wants to know how long the total period is for the water's rise and fall first has to verify the degree at which the moon rises over the hemisphere and has to take [the degree] that is diametrically opposite to it, and he will have the degree at which the moon sets. And he has to see how many degrees there are in between and calculate fifteen degrees per hour, and the time of its rise and fall taken together will be as great as how many hours he will have found. But if he divides that in two, then he will have the time for the rise alone and the time for the fall alone. But the method for finding the time for the second rise and fall is the same, except only for the fact that it is verified in that degree at which the moon sets, and the degree opposite it is taken in the east, and then the degrees of the arc that extends from the west to the east are counted, and it works just as it did earlier.

However, there are some who object to the things said what one finds in fresh water, as at the Arabs' city called Albsarach, and in the waters of the city called Acyn, and in the waters of many other places, and these places are situated at the edge of the sea.¹³⁴ Responding to them, however, we say that fresh waters are

133 For many ancient astronomers, the planets revolve about a small circle (an epicycle) that itself revolves about the earth in a circle known as the deferent circle. Both circles rotate in a counterclockwise fashion.

134 See Albumasar, *Introductorium* 3.5, p. 109, 845-857; See A., *Meteora* 2.3.8 (Ed. Colon. p. 90,12-13).

subtle¹³⁵ and do not retain the wind's vapor within themselves, and this is why they do not rise or fall, especially when they flow as rivers do, because then the motion renders them even more subtle. Moreover, the places of the aforementioned waters are reservoirs for the many rivers flowing into them, which push the salt water away from the aforementioned cities by their force, and this is why the water remains fresh water on the shores of the cities mentioned. Nonetheless, the fresh water is connected to the salt water because these places are at the edge of the sea, and this is why when the sea rises, the fresh waters are forced along and rise accidentally [*per accidens*], and when it falls, they appear to fall as well. And something similar occurs in wells that are near the sea, which grow from the overflowing of the water when the sea rises and decrease from the reduction of the water when the sea falls.

From what has been said it is also clear why the rising sea pours forth warm, fetid water and the falling sea draws with it cold but less fetid water. For when it rises, the warm and corrupted vapor enclosed within it is exhaled, and this is why sailors call that the heat and stench of the sea. However, when it returns, then the water that has been spread out upon the shores is cooled and refreshed, and this is why it becomes cooler and less foul smelling.

This then is the cause for the rise and fall of sea water.

CHAPTER SIX

THIS IS A DIGRESSION EXPLAINING HOW MANY AND WHICH THINGS STRENGTHEN THE RISES OF THE SEAS

However, it does not seem that one should continue here without saying something about those factors that strengthen the rise and fall of the sea. For although this is known perfectly only through astronomy, which makes known the course of the moon and the stars, it still pertains to natural [science] to know these things in a general way. But although the factors may be many in number, there are still five that have greater power to bring this about. The first of these is the moon's distance from the sun. The second, however, is the moon's proximity to the sea. But the third is its approach or retreat from the zenith directly over those who are near the sea. The fourth, however, is the length of time of the presence of it and the sun over the earth or under the earth. But the fifth is the assistance it receives from other stars. And these five are responsible for the strengthening or weakening of the sea's rise or fall by celestial power alone. There is also one factor beyond and in addition to these, and that is the force of the wind, which can be such that it strengthens the rise more than the fall and can be such that it strengthens the fall more than the rise. In addition to these, however, there are accidental and particular causes strengthening the rise or fall or both, which we will mention at the end of this chapter.

135 "Subtle": thin or fine and not thick or coarse.

I say then of the first cause that the moon's distance from the sun produces the quantity of light in the moon. Thus, when the moon is in the same position in the zodiac with the sun, then the luminary bodies move with a conjoined power, and this is why at that time the water's rise is strengthened because of this more than its fall, all other causes being equal. However, when the moon retreats, then only a little of the sun's light is in the moon, and it does not have the sun conjoined with it. And this is why at that time the rise weakens until there is a half moon, and then it withdraws from the sun through one quadrant of heaven, and then its light is strengthened, and so too is the sea's rise, and it does not cease to be strengthened until the moon becomes full, at which time the sea's rise is especially strengthened and its fall weakened. When, however, the moon wanes from a full moon, the rise begins to weaken until the moon is again a half moon, at which time it will be strengthened again a little owing to the moon's angle, which is a right angle. For a quadrant of the orbit [*circulus*] is extended beneath the right angle over the center for the existing [angle], and at that time it is again weakened until it is made to be with the sun. Nonetheless, the sea's rise is always stronger when the moon's light is waxing rather than when its light is waning. And because of this one finds that the sea rises for half the month and falls or remains stationary while not rising for the other half of the month, because its water is thick and cannot be moved unless the moon's light is waxing and its light is not waning. For every power is more powerful to bring about an effect when it is waxing than is the same power when it is waning to the same extent.

But the second cause is, as we said, the moon's proximity to the sea. For the moon has an eccentric deferent and epicycle, as do the other five planets.¹³⁶ And this is why when it descends toward the earth in each of these [circles], its motion is stronger on the sea than when it ascends, and if it should descend along the shorter part of the diameter in the eccentric [circle] and ascend in the epicycle, its motion is still strengthened even though it is not as strong as it was when it descended in both of these circles. And this occurs because everything that moves something moves it more strongly when it is near it than when it is distant from it. But the moon is nearer to the sea when it descends along the shorter part of the diameter of its circle than when it is ascending along the longer part of the diameter.

The third cause is the moon's approach or retreat from the zenith over those who are near the sea, which rises or falls because when the moon approaches the zenith overhead, then its rays more directly reach the bottom of the sea and move it more strongly, whereas when it retreats from that zenith, then its rays are dispersed over the surface of the sea in an oblique manner, and they cut

136 See A., *De caelo et mundo* 2.3.13 (Ed. Colon. p. 171,21-43); 2.3.10 (Ed. Colon. p. 162,38-54).

through the sea's convex surface, and for this reason they move it less at that time. For this reason the rise [of the sea] is strengthened and its fall is weakened when the moon approaches the zenith overhead, and when it retreats from the zenith overhead, then the opposite of this occurs, if all other factors are equal.

The fourth cause that strengthens the rise is the length of time for its [the moon's] presence over the earth with the sun. For sometimes its rise occurs during the day, and sometimes its rise occurs at night. Therefore, one must consider whether the day is longer than the night, or conversely whether the night is longer than the day, and if the day is longer than the night, which occurs when the sun is in the northerly signs, the day's rise will be strengthened more than the night's rise, especially if the moon is also over the earth longer than it is under the earth. And there is a significant difference in this because the season when the day is longer than the night is two, in one of which the day grows longer, but in the other it grows shorter. And when the days are growing [longer], then the diurnal rise is stronger than it is when the days are growing shorter. For this reason, all other factors being equal, from the spring equinox [*aequinotium aestivum*] until the summer solstice [*solstitium aestivum*] the diurnal rise is stronger than is the diurnal rise from the summer solstice until the autumnal equinox [*aequinotium hiemale*].¹³⁷ Nonetheless, at each season the day's rise is stronger than the night's. But at the two equinoxes the day's rises and the night's rises are equal, since at that time the sun remains above the earth and under the earth for an equal period of time. But from the autumnal equinox to the winter solstice, since in that season the nights grow longer than the days, the night's rise is stronger than is the night's rise that is from the winter solstice until the spring equinox, since in that season the nights grow shorter, although all of the nocturnal rises in both of these periods are still stronger than the diurnal rises during the same periods. But this occurs particularly when the moon is with the sun above the earth for a long time. And this is why if the moon ascends above any sea at the end of Gemini or the beginning of Cancer, its rise is strengthened a great deal, because no sign has as great a circle over the earth as the one that we mentioned. For this reason their days are also the longest. However, the opposite occurs when it is at the end of Sagittarius or the beginning of Capricorn, because the circle of these signs is the greatest beneath the earth, and their nights are the longest.

The fifth cause is the strengthening of the moon from three causes, namely, from [its] position, and from the fixed stars that signify an effusion of water, and from [the presence of] more or fewer planets. For when the moon is in the water signs and especially in Pisces or the end of Aquarius, its effects will be strengthened from the position of the heaven in which it exists. However, if the fixed stars that signify a flood are there, as do the four stars that are near

137 "Aequinotium aestivum and aequinotium hiemale": lit., the summer equinox and winter equinox.

the Out-pourer of Water [*Effusor aquae*], or as do the Pleiades and other very moist stars, then the moon's effects upon the rise of the sea are strengthened even more.¹³⁸ But if in that place the moon descends along the shorter part of the diameter and if the other two or three or four or five or all six other planets are conjoined with it in a moist sign and with the very moist stars, and if at that time all or several of the planets also descend along the shorter part of their diameter, then the increase will be excessive [*intolerabilis*] and lasting for a long time; it will perhaps last for many days, and it will perhaps even submerge nearby places, unless the increase is impeded accidentally because of hollow places that receive the escaping sea, or on account of some other accident.

Having determined the causes in this manner, then, one must consider whether more or fewer of them come together on one sea, and one must make a judgment concerning the sea's rise or fall in accord with this.

However, in addition to these the wind is a cause that exists in the lower regions either to bolster or impede the sea's rise. We said above that the wind is raised up in the depth of the sea, which causes the sea to bubble up, but it only rarely reaches as far as the sea shore. However, a strong wind that blows at the sea shore is raised up from the earth and is one of the twelve winds, concerning which we will make a determination in the book *On Meteors*.¹³⁹ And if the wind is strong and comes from the same direction from which the sea's rise comes, that is, from the east, then it will push the swelling sea before it, and it will strengthen the sea's rise. If, however, it comes from the west against the sea's rise, it will push back the water and will impede the sea's rise. And it is much the same for other winds. For the sea rises according to the moon's motion from the east and according to its motion from the west, when the moon sets from our hemisphere, and for this reason there are two rises, as we said. And this is why one must take into consideration whether a strong wind is blowing from the same direction as the rise or fall, as we have taught.

But sometimes the rise or fall similarly grows or decreases in an accidental way, that is, because of the Syrtes¹⁴⁰ or Scyllae¹⁴¹ or islands or broad shelters that block

138 For the Out-pourer of Water, *Effusor aquae*, see *infra* 1.2.9 (p. 75) and see Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis de Sacrobosco*, in *The Sphere of Sacrobosco and its Commentators*, ed. Lynn Thorndike, lectio 9, p. 175.

139 See A., *Meteora* 3.1.20-21 (Ed. Colon. pp. 120,60-123,26). On the twelve winds, see also 1 Enoch, 74.10-11.

140 There were two sandy banks on the coast between Carthage (*Syrtis minor*) and Cyrene (*Syrtis major*) held to be especially dangerous to shipping. For *Syrtis maior* and *Syrtis minor*, see A., *De nat. loci* 3.8 (Ed. Colon. p. 43, 22-24). According to Acts 27.10-19, the crew of the ship carrying the Apostle Paul to Rome for his trial were concerned that their ship would founder on *Syrtis [minor]*, on the coast of N. Africa.

141 Scylla is a dog-headed monster of Greek mythology that lived on the rocks of the Italian side of the Strait of Messina, devouring passing sailors, but which here refers

them, or even sometimes because of rivers. For when the sea rises, its impact is broken up by the Syrtes and by islands and hills that are in the sea, which hills are named the Dogs' Heads [*capitacanina*] and which the Greeks call Scyllae. And when its impact is broken, it pours out upon the shore with a modest and restrained flow and returns with great impact. But it is sometimes retained in a similar manner in broad places, and having been dispersed, it is spread out in them, and then once again it flows upon the shore with less impact and in a lesser amount. But sometimes it flows into flowing waters and causes the rivers to rise and to retain the waters and pool them, and then later it returns to the sea with all of these waters, and then its fall is greater and more forceful than its rise. However, sometimes the shore has a convex shape, and this convexity can be of two types, namely, toward the sea or toward land or perhaps toward both of these. And if the shore is convex toward the sea, the force of the sea's rise will always be broken on the shore's hump, and for this reason the sea always comes to its land with a modest flow; however when it is flat toward the sea and is convex toward land, then the sea rises with a double force, since it has one force from its own impulse and has a second force from the accident of the convex shape. However, sometimes it is convex in both directions, when there is a certain long mountain under water at the shore, as it were, and the force of the sea that properly belongs to it when it rises is broken on that mountain, and a second force remains, which exists because of the sea's drop [*casus*] beyond that convex shape. But the judgment is the same concerning the fall [*recessus*] of the sea; for when the rise is strengthened, then the fall is weakened and conversely. And when the period for one of these is lengthened, then the period for the other is shortened in most cases, unless it be impeded by some accident, as we said.

These then are the causes strengthening or weakening the rise or fall of the sea, and [there are] certain others that ought to be treated in astronomical [books].

CHAPTER SEVEN

AND THIS IS A DIGRESSION DESTROYING THE TWO ERRING SCHOOLS [SECTAE]

CONCERNING THE CAUSE FOR THE SEA'S RISE

There were some naturalists [*physiologi*], moreover, who said that the moon is the cause of the sea's rise, and there were two schools of them. For there was a certain Arab a few years before us in Arabic Spain, whose name is Alpetrauz,¹⁴² who said that the entire heaven is moved by a single and first mover, whose motion extends to everything that exists. And that motion

to islands in an archipelago.

142 I.e., Al-Bitrûjî (d. 1204) who, although he was born in Morocco, later migrated to Seville, Spain. See his *De motibus celorum: Critical Edition of Michael Scot's Latin*

revolves the fire and air with a perfect circular motion. But it does not move water in a perfect circular motion, but rather in a half circle [*semicirculus*] owing to its weight and density, and it is because of this that the sea rises toward a half circle of any land whatsoever and then falls from its own weight.

The other school said that the sea breathes on its own and not from the power of some celestial motion, and when it breathes, it is raised up and is poured out over its shores, and once it has breathed out, then it returns to its own sea bed. However, they said that an indication of this is that many breaths are born in moist and hot bodies. But since the sea is of enormous size and is moist, it is impossible that the sun's heat and the natural heat of the sea should fail to generate many windy breaths in it, which make the sea swell and breathe and disgorge itself.

But the refutation of Alpetrauz's statement is that if the sea were moved by the motion of the first mover that moves the diurnal motion, then the sea ought to be moved according to a diurnal motion in only one manner—from the east—and since the earth is round, there would be no reason why the water should return from one point of the circle [*circulus*] of the sea or the earth more than from another; and then the sea would complete a circle upon the earth; and then every day agriculture would be destroyed, as we said above in opposition to those who said that the sea is moved according to the diurnal motion of the sphere [*orbis*].¹⁴³ Since, then, we find that there are many different types of motion for the sea and many modes for its return, as is apparent from the things said above,¹⁴⁴ it is clear that the sea's water does not follow the motion of the prime mover, which is diurnal, in its rise and fall. Let us now dismiss the statements of Alpetrauz, then, because although he wished to speak as a natural scientist [*naturaliter*], he erred and led many others who followed him into error, as we showed in part in the second book of *On Heaven and Earth*.¹⁴⁵

But an argument against the second school is that if the sea were moved because it breathes naturally just as other things do in which the winds and windy vapors are generated, then its rise and fall always ought to exist according to one mode, because when their cause exists in one mode, the works of nature are in one mode. However, we do not find this to be the case for the sea, as is evident from the things already said.

Furthermore, if the sea breathes without being moved by the moon, then it is only moved from the bottom, and it always breathes, and in this way it is necessary

Translation, 8,1, ed. Francis J. Carmody (Berkeley and Los Angeles: University of California Press, 1952), p. 92.

143 See *supra* 1.2.3 (p. 48).

144 See *supra* 1.2.4 (pp. 52-55).

145 A., *De caelo et mundo* 2.2.5; 2.3.7, 11 (Ed. Colon. p. 136,39-40; p. 157,55; p. 166, 31-76).

for it always to have a larger place, and so it never returns, because from the fact that it breathes, it will always breathe by itself and always bubble over. And we do not see this, because we see that the sea returns; then its place suffices for it, and there is no breathing in it to expel it from its place.

But it is furthermore the case that it is water's nature to flow downward toward earth. If then it is raised up by breathing in, it will only descend below when it breathes out and will only be raised up while breathing in, but we see that the opposite is the case because we see that it follows the motion of the moon.

Still more, that which is given when something is given and is destroyed when it is destroyed, is caused by it. But we always see that the sea's rise is given and takes place when the moon touches the circle of the hemisphere;¹⁴⁶ it will, then, be seen to be caused by the motion of the moon. If someone should say, however, that it is not caused by the moon because if it were from the moon's [motion], it would have to occur in every watery, moist [body], and it would have to occur in this way in rivers and springs and in every pond, we will say that the disposition of water is not the same in all of these, as we said above.¹⁴⁷ For the sea is like a whole, and the rivers and springs and ponds are like parts, and the operation is not the same in the whole and the parts, since the whole gathers up many powers that the parts do not have. For rivers have subtle, fresh, moveable, and cold water for the reasons we mentioned above.¹⁴⁸ Ponds are thinned [*subtiliantur*] also from the visible or hidden springs that flow into them, and since there is little water, the springs are sufficient to thin them. And this cannot be the case for the seas, in which there is a large body of water. And this is why the seas flow out and flow back again, but not other bodies of water. Nonetheless, all bodies of water undergo some change from when the moon rises above them, although at times this is imperceptible.

But we see this especially in [a body having] a moist watery complexion that is natural to animals and plants and minerals. For when the moon's light is waxing during the first part of the month, we see that moisture abounds in the bodies of animals and especially in the bodies of humans, bubbling up to the surface of [their] bodies from the depths to the exterior, as it were, and that the skin is fuller and the joints of the members are more hidden, and that the veins are more concealed and are deeper, and more of the food that is consumed fattens them than at another time of the month, when the moon's light wanes. And we see that all these things occur more when the moon is above the earth during the day than when it is under the earth, and they occur particularly when it rises from the east to the middle of heaven, and they occur less than when it sets from the angle of the meridian. For this reason, wise physicians who want to fatten

146 See *supra* 1.2.4 (p. 54).

147 See *supra* 1.2.5 (pp. 58-59).

148 See *supra* 1.2.5 (pp. 58-59).

or strengthen some [patients] carefully observe the times that we mentioned. But the moon's motion is especially noticed in the case of the ill, and the critical days¹⁴⁹ are numbered according to it. And we have seen that many people who became ill at the waxing moon and when it was raised above the earth from the east to the middle of heaven, escaped serious illnesses because at that time nature was strong, there was a great deal of complexional moisture, and it was then moved by the nutritive motion of the body. We have seen others, however, die from lesser illnesses, who began to be ill when the moon was waning and when it was not above the earth, and particularly if the moon was retreating from the angle of the middle of the earth in the lower hemisphere.

However, the moist elements of newborns receive much variety in animals according to the motion of the moon, which we mentioned. They increase and come to maturity or putrefy at the aforementioned movements of the moon so that if an animal has an abscess and lies at night particularly under the rays of the waning moon, when the moon is in a hot heavenly sign, the animal perhaps dies from a small abscess since the moon does not then bring to maturity, but putrefies and corrupts.

However, when the moon waxes, moistures also similarly grow in the wombs of female animals, and when the moon rises from the horizon, the vital moist [elements] are filled with a vivifying spirit so that then they conceive easily and conceive male progeny more easily than at any other time. And the newborn conceived then is more vigorous than one conceived at any other time, especially if the power of the moon is increased from the five causes that we mentioned above.¹⁵⁰ And if there are eggs produced in the wombs of birds at those times, they will have a great deal of egg white and be very vigorous, because the white is the radical moisture out of which the bird's body arises and from which the yolk is prepared as food.¹⁵¹

In like manner, however, we find many of the aquatic animals that lie concealed in hiding places are both weak when the moon is waning and do not feed then, since their heat is weak. But when the moon is waxing, they come out and feed,

149 A. also mentions these "critical days" above at 1.2.4 (p. 52 and see note 118).

150 See *supra* 1.2.6 (p. 59-60).

151 The concept of radical moisture represents the substantial moisture conveyed to a body at the time of generation and, as such, was understood to be essential to life—to the assimilation of food and to the generation of the bodily members. Over time, the body's connatural heat, fueled by the radical moisture (see *Quaestiones super de animalibus* 13.13.2; Ed. Colon., p. 245, 13-16), diminishes the quantity of this moisture and accelerates the aging process, leading to the gradual desiccation of the tissues and internal organs. Disease or illness (e.g., fever) may also hasten this process (see *Quaestiones super de animalibus* 7.29; Ed. Colon. p. 184, 35-72). The radical moisture can never be completely replenished by the conversion of food into this moisture during digestion, resulting ultimately in the organism's decline and in its death.

and many of these only feed at the hour when the moon is elevated above the horizon to the middle of heaven, and at every other time they will return to hiding places and do not look for food.¹⁵² For they are very cold and have a viscous moisture that cannot be resolved by the natural heat to produce a movement toward and desire for food, except when the moon that has been strengthened will move and assist them. Moreover, it is apparent among river crabs that they are plump when the moon has become larger and they are weakened and emaciated when the waning moon has been diminished. Also venomous animals, whose moisture is poison and whose bite is poisonous, have a bite that is worse when the moon is waxing and strengthened in its light and is ascending from the circle of the hemisphere than at other times. For the venomous moisture is a natural moisture for them, and it is abundant and vigorous at that time, and this is why then it infects more those who are bitten.

However, an identical sign appears in plants, because those planted when the moon has increased in light and has been elevated from the circle of the hemisphere, grow strong with a modest amount of care and grow and produce fruit more quickly than others.¹⁵³ And those that are planted at the opposite times dry out, perhaps, or do not grow strong so easily or so quickly. Fruits and herbs are also more flavorful when the moon waxes and ascends from the circle of the hemisphere than they are at other times. And this is so known to experience [*sensus*] that not only the wise but also the community of farmers attest to this.

Those who work at the transmutation of metals and stones, whom we call alchemists, produce purer metals and turn out purer stones at the times of the moon's increase and when it is growing strong and ascending from the circle of the hemisphere, and the spirits are determined more and work more surely, and especially when they are very skilled, not hurrying their works, but awaiting the opportune moments when the task is assisted by celestial power.¹⁵⁴

But it would be tedious to introduce all the examples similar to these; for those that we have introduced concerning the individual kinds of things are adequate as proof of our aim.

152 See A., *De animalibus* 7.1.8.84 (ed. H. Stadler, p. 531).

153 See A., *De veg.* 7.1.9 (ed. C. Jessen p. 618).

154 See A., *De mineralibus* 1.1.1 (Borgnet, p. 2). For a discussion of Albert's understanding of the alchemist's art, see Robert de Halleux, "Albert le Grand et l'alchimie," *Revue des sciences philosophiques et théologiques* 66.1 (1982): 57-80.

CHAPTER EIGHT

AND THIS IS A DIGRESSION EXPLAINING THE DIFFERENCE
OF SEAS IN RISING AND FALLING

But having established all the things that it seemed necessary to mention about the cause of the rise or fall of the sea, we will now introduce the difference of seas in their rise and fall, finishing what we intend to say about this matter.

But we say that there are three kinds of seas in general, and there is for instance one kind [*genus*] in which there is no cause of a rise and fall, but there is another kind in which there certainly is some cause for a rise and fall, but still no rise and fall appear in it. There is, however, a third kind in which there is a cause for a rise and fall, and a rise and fall appear in it. But it is necessary that the kind of seas in which there is neither a cause for the rise nor the very motion for the rise come from one or more of three causes. The first of these is that the waters of some sea are few, which experience an increase in winter from the rains and a decrease in summer and experience an increase from flood waters. And these kinds of seas have the nature of pools, and their water is not very salty and is thin [*subtilis*], and for this reason it does not gather into itself the steam and vapor that causes a wind that expels the water, and these seas neither rise nor fall. For such are like certain [tide] pools adjacent to the sea, as it were, and owing to their breadth and their shallow depth one does not perceive in them the sea's rise, because it [the rise] will disappear from them first, before it overflows into the waters of such seas. A second cause, however, is that they are perhaps so far removed from the path of the moon and the planets that the moon never fixes its rays on it, but they pass through, cutting the water's smoothness, and this is why it is not surprising if a sea like this does not rise or fall. A third cause is that the earth of the sea in the bottom and banks is porous and soft, which does not hold the vapor generated in it, but gradually sends it forth, and then, as we said above, the sea does not rise or fall.

The seas in which there exists a cause, however, for the rise or fall and which still neither rise nor fall are also in this condition [*passio*] for three reasons. The first of these is that the moon's rise from the circle of the hemisphere only turns toward one of its shores, because the distance between one shore and the other is too great. Then the moon only moves one part of the water, and that one [part] is poured out over the other, and for this reason a rise and fall is not produced, but rather wind and a curling of the waves, as there is in the Pisaeon Sea.¹⁵⁵ Another reason is that although sometimes the moon will be in a straight line to some seas, it still does not have low-lying shores or islands over which it might be poured, but its rise is broken at the height of the shore, and it is only

155 That is, a sea of Pisa in Etruria.

perceived, perhaps, insofar as the sea strikes the shore one time more than on another. But a third cause is the flow of the sea. For some sea flows, and when it is moved by the moon, it breathes and immediately flows out before it can be pushed out by the breath beyond its location, and for this reason it is not gathered in order that it might rise all at once but flows out bit by bit, and its rise is not observed.

However, the seas in which a rise and fall are observed are those that have dense water and a solid bottom and solid, very often mountainous shores and that have shores that are sunken, flat, and broad in some place, over whose flat surface the water might be poured and from which it might have an unhindered return to the sea, as we said above,¹⁵⁶ like the Indian and the Persian Sea and the one that is between Constantinople and Venice, and the sea that is the Ocean's bay [*gumphus*]¹⁵⁷ in the north, near where we ourselves live.

But what is more amazing to everyone is written and described by mariners concerning the Persian Sea and the Indian Sea. For they say that those two seas are connected to one another, and yet they have a large island by which they are divided, and their properties are wondrous. For the Persian Sea is navigable easily and in tranquility from the sun's entry to the beginning of Pisces, until it enters the beginning of Virgo, and then it begins to steam and is cloudy, and its waves are continuously raised up until the sun enters the beginning of Pisces again. Yet its elevation and steam and tempestuousness are still greatest when the sun is in Sagittarius in the end and the beginning of Capricorn, and then many sailing on it are imperiled. Nevertheless, it is always somehow navigable, and it is that way likewise with the Great Western Sea and with all the seas that are near us in the seventh clime. But the Sea of India has a property that is contrary to these seas. For it is itself tranquil for the entire time that the sun is moved from the beginning of Virgo to the beginning of Pisces, and its greatest tranquility is when the sun is at the end of Sagittarius and in the beginning of Capricorn. From the beginning of Aries until the beginning of Virgo, however, it is tempestuous, and it is especially tempestuous when the sun is at the end of Gemini and in the beginning of Cancer, and at that time the Persian Sea is especially tranquil. And what greatly increases one's admiration is that these two seas have continuous waters, and although each is unnavigable at opposite times, the Indian Sea becomes altogether unnavigable and dark when the sun is in Gemini and in Cancer. The Persian Sea, however, is navigable with difficulty and with danger and not altogether dark when the sun is moved in Sagittarius and Capricorn.

¹⁵⁶ *Supra* 1.2.6 (p. 63).

¹⁵⁷ For the meaning of *gumphus*, see note, above, at 1.2.4 (p. 54, n. 126).

And in fact many natural philosophers and astronomers, such as Albumaxar, and certain others report this.¹⁵⁸ Still they only assign a universal cause, strongly asserting that this stems from the sun, because the sun, not only the moon, has marvelous effects in moving the water of the sea. But this does not suffice, because it is necessary for the natural philosopher to know the proper and true causes.

And for this reason one must say that the Indian Sea has water that is denser than the Persian Sea. The reason for this is that it lies more toward the south, and the sun's warmth will mix it with much earthiness and extract the subtle moisture from it, and a coarse earthiness, like sediment, will remain. And once this heat has been diminished, it cannot be moved, and for this reason when the sun is descending to the south, when it is in the beginning of Virgo, it [the sea] is not moved and does not breathe out, and this is its tranquil state, when the sun is most distant in the south, and this is when it is in Sagittarius and Capricorn. For then its water grows calm, and nothing can move it to breathe. But when the sun begins to ascend above it from the south and approaches it toward the equator in the sign of Pisces, then it moves its water, and its coarse breath does not emerge through subtle parts, but rather through dark clouds, because it is abundant and thick, and for this reason it is very dark, and when its state is tempestuous and dark, the sun can do this most, and this is when it is particularly hot, ascending above it in Gemini and Cancer. The Persian Sea, however, has subtle water and a subtle breath, and the breath emerges gradually when the sun is in the northern signs, and this is why the Persian Sea is tranquil at that time. However, when the sun is in the winter signs in the south, then its breath is made dense by cold and, coming forth dark and strong, it causes a storm. That the Indian [Sea] is altogether unnavigable in summer, however, is due to the fact that, when it grows warm, its thick vapor retains a lot of heat owing to the earthiness and thickness of its matter, and thus it is not calmed, but instead it disturbs the sea powerfully and continuously. And the breath of the Persian Sea does not do this, as is clear to every person who knows the natures of earthy vapors, which we will determine in the book *On Meteors*.¹⁵⁹

Moreover, one ought not pass over the fact that neither the Dead Sea¹⁶⁰ nor the sea that is in Ethiopia, and which some call the Indian Sea, because it is connected to it on one side through a certain bay,¹⁶¹ rise or fall, although the moon and the sun still rise and set over these seas. And this is the reason for it: the water in each of these seas is so very thick, and neither the light of the sun nor

158 Albumaxar or Albumasar, i.e., Ja'far ibn Muhammad Abū Ma'shar al-Balkhī (d. 886), an influential Persian astrologer. The previous paragraph treating the Persian Gulf and the Indian Sea closely follows his *Introductorium* 3.8, ed. R. Lemay, pp. 128-129.

159 See A., *Meteora* 1.4.1, 3 (Ed. Colon. pp. 34-36).

160 See A., *Meteora* 2.3.16 (Ed. Colon. p. 97, 29-31).

161 Perhaps, the Gulf of Aden.

of the moon can penetrate it, nor can they thin its vapor so that it bubbles up, and for this reason it stands still and neither rises nor falls. And an indication of this is that nothing whatsoever lives in these seas nor does anything germinate near them, nor are they very navigable, owing to the thickness and corruption of the water. Also bodies that sink in other seas float in these seas owing to the thickness of their water. But the judgment is the same for the other seas.

These then are the things that should be said concerning the rise and fall of the sea, as far as it refers to this purpose. Some things that belong to this science still remain to be discussed in the judgments of the stars, which we will treat, Lord willing, among the mathematical sciences.

CHAPTER NINE

AND THIS IS A DIGRESSION EXPLAINING THE CAUSES OF FLOODS OF WATER

Now one ought to look at the cause of a flood. We will state, however, the natural causes for a flood.¹⁶² But it is necessary to know that among the authorities one of the floods is said to be universal and another is said to be particular. Also, one of the causes of a flood is universal, another is less universal, and still another is particular. For there was a universal flood that submerged the entire habitable earth, as occurred at the time of Noah,¹⁶³ as Moses recalls, which I think was the same flood that occurred at the time of Deucalion and Pyrrha, as the Greek and Latin poets attest.¹⁶⁴ However, there has more frequently been a particular flood that perhaps submerged a single land or flowed over it for a time, although it did not submerge it entirely. However, the cause for a universal flood is one in which all the celestial and terrestrial factors that cause an inundation of water coincide at the same time. But the cause of a less universal one is one in which some of the celestial and some of the terrestrial causal factors coincide. A particular cause, however, is one in which either only some of the celestial factors coincide or only some of the terrestrial factors coincide. But the ancients who theologized about this were not ignorant of this, and this is why they said that, when Jupiter wanted to send a flood, he had his brother Neptune help him, intending to say thereby that it was not by Jupiter, that is, by celestial power alone, that there was a flood, but also by Neptune, who represents the lower power, and that these powers sometimes move the waters

162 "Natural causes": i.e., as opposed to possible theological reasons for the flood.

163 See Gen. 7.11-24.

164 Deucalion is, in fact, the Greek Noah in that he and his wife Pyrrha, due to their piety, are chosen by the gods to survive the "Universal Flood" of Greek mythology. They are told to repopulate the earth by casting behind themselves the "bones of their mother," which they find, to their relief, means the stones of Mother Earth. The most common version of the tale is that of Ovid, *Metam.* 1.262-415.

from lower places on the earth to higher ones.¹⁶⁵ But Jupiter and Neptune are said to be brothers because from the same constellation a higher power is born that converts vapors and air into the waters, as well as a lower power that causes the waters to bubble up from the earth to the surface of the earth. For this reason Jupiter is also said to have descended to the lands and to have seen the malice of those living on earth.

There are, however, some who attribute all these things to a divine disposition alone and who say that we should seek no cause for things of this sort other than the will of God. We agree with them in part, because we say that these things occur by the will of God, who governs the world, as a punishment for the evildoing of men. But we still say that God does these things on account of a natural cause, of which he who confers motion on all things is himself the first mover. However, we are not seeking causes of his will, but we are seeking the natural causes that are like certain instruments through which his will in such matters is brought into effect.

It is the opinion of some of the Arabs, however, that wonders of this sort occur on earth from the imagination [*imaginatio*] of the intelligence that moves the sphere of the moon, and not from the moon itself or from some other star.¹⁶⁶ For they say that just as the body of a man is related to the soul, so the whole corporeal matter of things subject to generation and corruption is related to the mover of the moon, because it is the proximate mover of such matter. And for this reason just as, when some form has been imagined, our body prepares itself because of the obedience that it has toward the soul to assume it, so too the entire matter of things subject to generation and corruption is moved to assume every form that the moon's mover imagines. And because the matter of bodies subject to generation follows in this way upon the power and imagination of this mover, they say that the intelligence itself, which moves the sphere of the moon, was said by Plato to have been the world soul¹⁶⁷ and was called by Orpheus the god who fills all things.¹⁶⁸

Some of the others, however, say that there is no cause of this sort, but rather an orbital deviation [*exorbitatio*] of superior bodies.¹⁶⁹ But an orbital deviation

165 See Ovid, *Metam.* 1.vv. 262-415.

166 Algazel, *Metaph.* pars 1. tr. 5; for the text, see Algazel's *Metaphysics: A Medieval Translation*, ed. J.T. Muckle, St. Michael's Mediaeval Studies (Toronto: Institute of Mediaeval Studies, 1933), pp. 122, 12-129, 23. Generally speaking, the intelligences act in the natural order, e.g., to keep the celestial bodies properly regulated, performing functions that correspond roughly to the acts of angels in the spiritual order.

167 See Plato, *Tim.* 34B, trans. Chalcidius (ed. J.H. Waszink p. 26,17).

168 "Orpheus": see A., *Metaph.* 3.1.2, 11.2.28 (Ed. Colon. p. 109,21 and p. 519,31); A., *De anima* 1.2.12 (Ed. Colon. p. 50, 67-71); A. *De natura et origine animae* 2.12 (Ed. Colon. p. 36, 68-71).

169 See Plato, *Tim.* 22D, trans. Chalcidius (ed. J.H. Waszink p. 14,11).

occurs for us because after a long circuit the planets raise the axis of the sphere, which is called the *meguar*,¹⁷⁰ and sometimes lower it.¹⁷¹ But when they lower it, then the water becomes higher than the earth, and for that reason it inundates the earth and submerges it. And these things were also said by some Platonists and Egyptians. It would be long and useless, however, to pursue all the opinions that were stated by our opponents concerning this.

For these that were said by the natural scientists [*physici*] were said according to a certain line of reasoning. For the view that the mover of the moon is the cause of this wonder, which is called the flood of water, by the imagination [*imaginatio*] seems to have some truth to it since, although the mover of the moon moves the moon not by imagination but by knowledge [*scientia*], this knowledge still rules and orders the course of the moon and the impressions that are produced in the matter of things subject to generation, and the matter obeys it. But merely to say this is the cause is not a reason. For that is a general cause both of this wonder and of others. We know, however, from what was said in the second book of the *Physics* that a general and universal cause does not act as a cause unless it becomes a proper cause through something added to it, and this proper factor ought to have been determined in nature by them. For it is not sufficient to know a cause in the universal, but we seek to know each thing in accord with what it is in its proper nature. For this is the best and perfect type of knowing.

One cannot say that the mover of the moon is ineffective in imagination, as we are, since if this were the case, its motion would be without order, and it would follow upon this that nothing at all would remain ordered in the lower bodies. However, those who have proposed a disorder and aberration in the elevation and depression of the *meguar* of the sphere as the cause of the flood, have not referred this back to the first sphere, whose *meguar*, like its center, is immobile, but only to the sphere of the moon, which sometimes ascends and at other times descends. And then because it is necessary that the center of its circle descend and ascend, it is also necessary that its poles descend and ascend. But with these descending and ascending, it is necessary for the *meguar* of the sphere of the moon to descend and ascend, which nonetheless does not occur in an arbitrary fashion, but according to a course ordained by intelligence. But it was called an aberration by the ancients because it is not always related to the center and the *meguar* of the world equally, but rather unequally.

Abandoning these things that were said both obscurely and imperfectly, we say that it was mentioned above that the cause of the flood that covered the earth was a conjunction that occurred in the sign of Pisces. It is necessary to know, then, that there are many conjunctions of the planets. For sometimes all the planets

170 For *meguar*, see *De animalibus* 1.2.14.303 (ed. H. Stadler, p. 107; SZ 1:159); *De prin. motus proc.* (Ed. Colon. p.61,96); *Metaph.* 5.2.2 (Ed. Colon. p. 237,46).

171 See *supra* 1.2.3 (pp. 48-49); A., *De XV probl.* (Ed. Colon. p. 38,58-61 with note 58).

are conjoined at the same time in a single sign and in one degree of the sign and in the same minute, that is, the sixtieth part of a degree, but sometimes fewer planets are conjoined, that is, six or five or four or three or two, and this occurs with many variations, and there are as many variations as there are ways in which the planets can be diversified in number and conjunction, and it is the case, as we said, that there are seven conjunctions consisting of six each. For they can all be conjoined except Saturn, or they can all be conjoined except Jupiter, and likewise they can all be conjoined except Mars, and likewise except the Sun or except Venus or except Mercury or except the moon. However, a conjunction consisting of seven planets exists in only one mode, when all the planets come together, just as a conjunction consisting of five also occurs in many modes so that Ptolemy said that the number of these conjunctions is one hundred and twenty, which is easy to discover following the mode that has already been mentioned concerning a conjunction consisting of six. But because this is not useful here, we therefore pass over it.

However, one should further note that when two or more planets are conjoined, they can come together in two ways. For either they come together in such a way that the lower one covers and eclipses the higher one, or in such a way that they stand next to each other, as if all that are said to be conjoined stood on a single line of the circle of the meridian, and this of course happens when they are in the same longitude from the east and from the west, but they are not on the same latitude from the equator. And when the planets come together in the first manner, then the conjunction is said to be true; however when they come together in the second manner, then the conjunction is called untrue. But the conjunction is said to be true because since the stars are luminaries absorbing for themselves the light that is directed to them, then the lower one absorbs for itself the light of the higher all the way to its center and forms it by its own power. And we can see an analogy for this in the human body, where one member transmits the spirit and humor of another, and yet the member that receives them informs them according to its own nature and power. In that way the brain informs the spirit and the humors sent to it by the heart and liver into the animal power and operation, and the testicles inform the spirit and humor sent to them for the power capable of generating and forming the species.¹⁷² Every planet that receives light from another acts in this way, and we can see this in the moon, which receives light from the sun and forms it for its own power so that it is cold and moist, although in the sun it is hot and temperately dry.¹⁷³

But it still must be noted, as we said above, that when the two stars [Saturn and Jupiter], which are more universal in moving and which are stronger since they are higher, are conjoined, they sometimes change the triplicity in which they

172 See A., *De caelo et mundo* 2.3.5 (Ed. Colon. p. 153,1-25); 2.3.6 (p. 154,9-86).

173 See A., *De caelo et mundo* 1.1.11 (Ed. Colon. p. 29,65-68); 2.3.3 (p. 157,55-56).

existed earlier, whereas sometimes they are conjoined in the same triplicity in which they were previously conjoined.¹⁷⁴ However, when they change triplicity, then they become new, as it were, in moving, and this sort of conjunction signifies great accidents and marvels as well as changes in the general state of the elements and of the world. A natural scientist ought to state the cause for this on his own, because an astronomer knows such things.¹⁷⁵ And this is why the Philosopher says that astronomy is another part of natural science,¹⁷⁶ and Ptolemy says that someone who judges, chooses, and observes the stars will err if he is not a natural scientist. The actual cause, however, is surely as follows. For since we already know through the things stated in *On Heaven and Earth*¹⁷⁷ that there is a universal cause for the shape and form that exists in heaven and that the heaven that is nearer to the mover ought to be more universal in causing it, it is necessary that what exists universally in a higher body be determined by lower bodies, and that which first determines it to shape and species is the starry circle [*circulus stellatus*]. But the first that lead to complexion are Saturn and Jupiter, because the one moves the dry and cold and the other moves the hot and moist. And when these two come together with that triplicity of a sign by which it is necessarily strengthened and receives influence, it is necessary that a disposition be poured out on the entire world by these two stars. But a change of triplicity bespeaks a change of the first elemental qualities in a universal fashion. It is necessary then that when these two stars change triplicity, a change of the whole world is perceived, as far as the lower bodies are concerned.

With these things already established in this way, I say, therefore, that the cause of the universal flood is comprised of four causes, of which one was a true seven-planet conjunction. The second is that all or many of them were in the lower part of their revolutions. The third is that the conjunction was such that it began in the sign of Aquarius near the four stars that are called the Water Pot of Aquarius [*Hydria Aquarii*] and which some call the Out-pourer of Water [*Effusor aquae*], because it was discovered that they have a special, wondrous effect in moving the waters.¹⁷⁸ And when what began there crosses over into the sign of Pisces, which belongs to the triplicity of water and has the great-

174 *Supra* 1.2.2, p. 46 (ed. Colon. p. 64,89-65,18).

175 This would seem the best translation of a sentence that is far from clear. We take "naturalis" as a substantive, indicating "natural scientist." Note that earlier editors emended the text at this point. We have tried to preserve Hossfeld's reading.

176 Ar., *De caelo et mundo* 1.6 (274a19-24); A. *De caelo et mundo* 1.2.3 (Ed. Colon. p. 39,71-75 and p. 43,16-24).

177 A., *De caelo et mundo* 2.2.5 (Ed. Colon. p. 136,58-p. 137,10); 3.15 (p. 178,28-88); 1.7 (p. 124,87-p. 125,7).

178 On the *Effusor aquae*, see *supra* 1.2.6, p. 62 (Ed. Colon. p. 71,93).

est power in that triplicity (more than Cancer or Scorpio),¹⁷⁹ and which was a change of triplicity in that conjunction, it was necessary then that the triplicity which previously held sway in the world be airy—and air by its moisture and convertibility is conducive to an abundance of water. I say, however, that a given conjunction begins in one sign and is completed in another when the centers of the epicycles or the epicycles themselves approach each other earlier in one sign and the actual planets gradually come together in another. The fourth and last cause is, however, that the moon was strengthened in its powers at the hour of conjunction, such that it was itself ascending from the circle of the hemisphere,¹⁸⁰ and that this conjunction was directly over the water, and that it was at the hour and day of the moon. For then without doubt the moon had within itself whatever light was in all the planets.¹⁸¹ And the moon moves with all that light according to the nature of the moon, and for this reason the water did not then advance gradually but leapt forth, as it were, toward the moon from the deepest bowels of the earth.

But another cause was in the lower bodies, it too universal, since it was necessary that on account of the motion of the water there be at that time many vapors in the air and that the power of the moon prevail in it, and for this reason the rains poured forth that converted both the vapors and much of the air into water. And this is one part of the lower cause. A second, however, was that there were many thick and strong vapors in the earth, which burst forth from the solid earth into the waters and cast out the waters from the depths of the abyss, from the thrones of Neptune, the brother of Jupiter, who dominates over the air.

And this is what the Greek and Latin poets sing about in mythic verses,¹⁸² and yet Plato asserted in the *Timaeus* that truth lay under them.¹⁸³ For that Jupiter convokes the meeting of the gods against Lycaon¹⁸⁴ was nothing but a conjunction of the planets and fixed stars that had occurred in one sign and one degree, in which the first moving body, which was the constellation of Pisces, had the nature of water, and the last moving body, which is the moon, also had the nature of water. And for this reason it was necessary that those in between also had their light changed to the same nature. Their statement that the high gods held a more worthy place in the hall and the popular gods held other places that they were able to attain by lot was said because the celestial bodies are higher

179 This is the watery triplicity.

180 See A., *De caelo et mundo* 2.2.5 (Ed. Colon. p. 135,12-39).

181 See A., *De caelo et mundo* 2.3.15 (Ed. Colon. p. 178,7-14).

182 Ovid, *Metam.* 1. vv. 163ff.

183 See Plato, *Tim.* 22D, trans. Chalcidius (ed. J.H. Waszink p. 14,10).

184 In Greek mythology, Lycaon was a King of Arcadia who entertained Zeus with a meal of human flesh. It is notable that in Ovid's text, which A. is following here, this story precedes that of the flood, and of Deucalion and Pyrrha, whom A. discusses above.

in causing such wonders and their power is like the first judgment [*sententia*], and the lower causes, which are called lower powers, do as much as is given to them by the celestial bodies.¹⁸⁵ The people of the gods and the secession of the house of Lycaon was nothing but the outpouring of the light of the stars into the sign of Pisces and into the moon, because a star is said to be burned [*combusta*] when it is under the rays of another one and especially of the sun.¹⁸⁶ However, it proceeded ultimately in the inundation of the flood against the villainy of men and of those inhabiting the earth, as has been said.¹⁸⁷

This, therefore, is the cause of the universal flood that was certainly universal in the greatest way. A lessening, however, of the factors that contribute to this produces the cause of a particular flood, and the flood will be less to the extent that the fewer and weaker causes come together. For sometimes the wind alone from an earthquake produces a particular flood, but sometimes a vapor and even some of the celestial powers are present, as we have said,¹⁸⁸ and it is easy to know all these things from what has already been said. The discovery of the time of the flood, however, and its size and precise place, can only be known by the science of the movement of the stars.

Let these, then, be the things said about the properties of water.

CHAPTER TEN

AND THIS IS A DIGRESSION EXPLAINING THE PROPERTIES OF AIR DESCRIBED BY THE ANCIENTS

After these things, however, one must speak about the properties of air and in particular make a determination concerning its movements, whether it sometimes rises and falls like the sea and whether it sometimes floods. But there seems to be no reason for air not to rise and fall because of the property of some star, since it is itself more movable than water and is simple, and it is appropriate for a simple [element], which is nearer to the stars, to be moved more by the stars than one that is more remote from them.

But it seems to be the case, on the contrary, that we neither perceive nor experience that motion; for if there were such a motion, then it would be necessary that it be perceived, as the wind is perceived. However, it is not perceived. Besides, Alpetrauz¹⁸⁹ was undoubtedly mistaken when he said that each day air is moved

185 The Latin in this sentence simultaneously plays on the double meanings of “superior” (higher/superior) and “inferior” (lower/inferior).

186 A. is commenting directly on the text of Ovid, *Metam.* 1.vv. 151f. and is attempting to elucidate some of the poetic language found there.

187 *Supra* 1.2.6, p. 60 (Ed. Colon. p. 70, 80-85).

188 *Supra* 1.2.9, p. 71 (Ed. Colon. p. 76, 57-74)

189 I.e., Al-Bitrûjî. See his *De motibus celorum* 4,3-7; 7,8-9, ed. F.J. Carmody p. 81 and p. 89. See Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis Sacrobosco*,

in a circular fashion more than water is. For since air is more movable than water, if it were moved in a circular fashion, its circulation would be perceived. Still it is not to be denied that air is moved by the celestial bodies, but it is the spheres of the five planets—Saturn and Jupiter, Mars, Mercury, and Venus—that move it. And because those [wandering] stars have many [kinds of] movements, for this reason the motion of the air is great and varied, because the five stars besides the sun and the moon have many diverse kinds of motion.

However, the ancients determined four things concerning the air. One of these is that it is in between heaven and earth and shares with each of them, by receiving steam and vapors from the earth and bringing them to heaven as nutriment, something that the Egyptians said, and Seneca followed them in this regard.¹⁹⁰ But it also receives the powers of the stars from heaven and conveys them to earth. And the first of these views has been proved false already in *On Heaven and Earth*.¹⁹¹ However, the second one, that air in fact conveys the powers of the stars to earth, is true since the power of an extreme only reaches [the other] extreme through what is in between,¹⁹² and for this reason it is necessary that all the power of the stars reach earth with fire and air as intermediaries. It is not true, however, that air is in between in the sense that it touches and separates both of the extremes, as Seneca meant to say.¹⁹³ He, nonetheless, held this opinion, following the Egyptians,¹⁹⁴ who said that fire is nothing else but that from which the celestial bodies come, and that it is not something that exists between one sphere and another, as the ancients said.¹⁹⁵ There is also a good bit said about these matters in *On Heaven and Earth*,¹⁹⁶ where it is proven that heaven is none of the four elements.

But the second view is that air is itself the most powerful of all the elements, because they saw that it throws down towers and rocky outcrops with [its] wind and splits trees with thunder. And they gave as an analogy of this that they saw minute seeds in rock walls gradually penetrate and split the stones, and for this reason they said that it is not surprising if blowing air also splits and casts down large bodies. There is a mistake also in this, however, because air really is more easily altered than one of the other elements, and this is why it is easily broken up into sounds and voices and is easily thickened or thinned. The fact, however, that it casts down and splits [bodies] is due to the fact that it is a vehicle of a

lectio 2 (ed. L. Thorndike, p. 150).

190 See Seneca, *Naturales quaest.* 2.3.4-5 (ed. Loeb, vol. 1, pp. 105-106).

191 A., *De caelo et mundo* 2.3.2 (Ed. Colon. p. 144,34-p. 146,12).

192 See A., *De caelo et mundo* 2.3.11 (Ed. Colon. p. 167,14-15, with notes 13 and 14).

193 See Seneca, *Naturales quaest.* 2.3.4-5 (ed. Loeb, vol. 1, pp. 105-106).

194 See A., *De caelo et mundo* 1.1.4 (Ed. Colon. p. 12,80-13,29).

195 See A., *De caelo et mundo* 1.1.9 and 2.2.1 (Ed. Colon. p. 24,17-45 and p. 128, 11-80).

196 See A., *De caelo et mundo* 1.1.5 (Ed. Colon. pp. 14,25-16,39).

percussive power, just as it is a vehicle in the body of the natural power of the natural breath. And for this reason this does not come from the power of air, but from the power of what first strikes the air. This has to be determined, however, in the book on *Meteors*, where one will find a treatise on thunder.¹⁹⁷

But the third view that they express about air is that it provides natural increments to all things that grow; for they see that the soil in gardens is neither consumed nor diminished, no matter how much it flourishes with plants and trees, and great increments are given to forests though the earth and water remains, as they say, in the same way. And this is also completely false, because growth results from nutriment. But it will be proved in the later books *On Generation and Corruption* [*Peri geneseos*]¹⁹⁸ and *On the Soul* [*De anima*]¹⁹⁹ and in other books that no composite is nourished by a simple [element], just as nothing is composed of a simple [element], a fact that is also shown by the activities of peasants who mix water with dung when they want to water plants. According to what they have said, however, it would not be necessary that plants be watered by rains, nor would it be necessary that animals be fed, since air would both nourish and increase each of these to maturity [*ad statum*].

However, the fourth view that the ancients expressed about air is that it was the breath of the gods. For they said that air is of course continuous up to heaven and that air is what separates [one] sphere and [another] sphere, and for this reason they said that the celestial powers, which celestial things they called gods, are first brought into the air as by a vehicle by which they might then be carried to everything that exists. They also said that the gods and souls are drawn into existence from it because it is animated and lives. And this was said to be the opinion that is found in the poems of Orpheus.²⁰⁰ Now this has some truth, but it is still mixed with myth. For it is not true that air reaches heaven, as was held above and as will also be maintained in the second [book] of this volume,²⁰¹ but the celestial powers are transported through the air on the rays of the stars, which travel through the air, and the rays are united to lower [bodies]. Nonetheless, they are more efficacious in these powers than is air itself.

But we will have a special investigation and consideration in the book *On Meteors* concerning the divisions of air through the interstices and concerning

197 A., *Meteora* 3.3 (Ed. Colon. pp. 151-74).

198 A., *De gen. et corr.* 2.2.17 (Ed. Colon. pp. 199,67-200,50).

199 A., *De anima*, 2.2.5 (Ed. Colon. p. 90,13-22 with note 21); *De caelo et mundo* 2.1.4 (Ed. Colon. p. 111,35).

200 See Ar., *De anima* 1.5 (410b 27-30); A., *De anima* 1.2.12 (Ed. Colon. p. 49,81-82 and p. 50, 67-71); *Metaph.* 11.2.28 (Ed. Colon. p. 519,31-33).

201 *Infra*, 2.1.2 (p. 102).

the movements of air and vapors and lightning flashes and the other things generated in air.²⁰²

Let these things then be said here concerning the properties of air.

CHAPTER ELEVEN

AND THIS IS A DIGRESSION EXPLAINING THE PROPERTIES THAT FIRE HAS, BOTH IN ITS OWN PLACE AS WELL AS WHEN IT GOES OUTSIDE ITS PLACE

But next we shall speak about fire and its properties, concerning which it is necessary for us to determine three things. The first of these is of what sort fire is in its sphere; the second, however, [is] by what nature fire is preserved outside its own place, since this does not suit any other element. And the third will be about its motions and the flood of fire, which Plato touches on in the *Timaeus*.²⁰³

We say then that in its own place fire is the most rarified in appearance [*species*] of the elemental bodies, and on account of this it is the lightest [of all elemental bodies] and is in a place that is up above in an absolute sense.²⁰⁴ But philosophers ascribe that place to it because it is connatural to it, since motion and light [*lumen*] dissolve and rarify bodies. Because of this, elemental matter cannot exist in a more rarified and loose-textured manner than it does under the form of fire. But it is the hottest [of all elemental bodies] because motion and light generate heat, and for this reason heat has been made natural to fire, and heat exists in it in the ultimate degree, and this is why it is capable of removing all moisture.²⁰⁵ For this reason heat suits fire in a way more essential than dryness, because dryness is caused by the heat that is in fire.²⁰⁶ However, some said that it is not a continuous [body] on account of its dryness, but that it [is constituted] from triangular and round atoms, since they said that only what is moist is continuous, since moisture causes parts to flow into one another, and thus moisture is the cause of continuity.²⁰⁷ However, since fire does not have moisture, it is not continuous. And they say that an indication of this is that it is a transparent body, asserting that a continuous body is not transparent, but rather that every such [continuous body] blocks vision. They also added

202 A., *Meteora* 1.1.7; 2.1.3 (Ed. Colon. pp. 10-11; 44-45).

203 Plato, *Tim.* 22A-23C, trans. Chalcidius (ed. J.H. Waszink p. 13,18-15,11); see *infra*, 1.2.12 (pp. 83-89).

204 See A., *De caelo et mundo* 4.2.6 (Ed. Colon. p. 265,65).

205 See A., *De caelo et mundo* 4.2.11 (Ed. Colon. p. 274,60-62).

206 See A., *De gen. et corr.* 1.1.8 (Ed. Colon. p. 117,41-48).

207 See Ar., *De gen. et corr.* 2.2 (329b 30-31); A., *De gen. et corr.* 2.1.5 (Ed. Colon. p. 181,3-14).

that fire descends into air in atoms and produces light in it, and this is what illuminates the air.²⁰⁸ The first authors of these opinions were Democritus and Leucippus, whose opinion has been treated more extensively in the first book of *On Generation and Corruption* [*Peri geneseos*].²⁰⁹ But, insofar as it pertains to the present purpose, one must know that moistness is the cause of continuity in mixed [bodies] but not in simple ones; for according to definition a continuous body is moveable before it is moist, on account of which the body of heaven is continuous and not moist, and for this reason the moisture is not the cause of continuity in all things.²¹⁰ And for this reason those who say that moisture is universally the cause of continuity err with respect to the conclusion, because they should see that it [moisture] is the cause of continuity in mixed bodies. Nor is it transparent for the reason that is not continuous, because we also see that moist bodies are transparent, as is evident in air and in water and in a crystal and in many other things, and this is why that opinion is false.

But fire does not cast light in its own proper sphere, and we have adduced arguments to prove this in other places.²¹¹ But what Alexander and Avicenna say suffices here as proof, namely, that if it cast light, it would hide and conceal every body that is behind it, just as everything that casts light does.²¹² However, since it does not hide any of those bodies that are above it, it follows that it does not cast light in its place. There are some, however, who say that it casts light in its own sphere,²¹³ offering as a proof of this the whiteness of the galaxy that bears the name "the Milky Way," through which the gods above assemble in the hall of Jupiter, as Ovid says.²¹⁴ But these people should be laughed at, because the galaxy is said by all authorities and astronomers to be a part of the starry heaven that fire never reaches and is far more distant from fire than fire is from the earth.²¹⁵ And this is why one marvels at the foolishness of those men who say that that [the galaxy's whiteness] is fire's light and that fire's light still does not shine brightly upon the earth. But the poets' statement that this is the road of the gods to the hall of Jupiter was said because Jupiter's house is Sagittarius, in which the Milky Way is particularly spread out. For this reason, those who say such

208 A., *De caelo et mundo* 2.3.1; 1.3.4 (Ed. Colon. p. 144,20-27 and p. 62,77-63,44).

209 A., *De gen. et corr.* 1.1.8, 1.1.10, 1.1.12 (Ed. Colon. pp. 117,41-118,30, 119,5, and 120,41-80).

210 See A., *De gen. et corr.* 1.6.10 (Ed. Colon. p. 175,20-43).

211 A., *De caelo et mundo* 2.3.1 (Ed. Colon. p. 143,37-40 and note 39).

212 See A., *Meteora* 1.2.6 (Ed. Colon. p. 22, 69-23,5).

213 See A., *Meteora* 1.2.2 (Ed. Colon. p. 19, 24-39).

214 Ovid, *Metam.* 1. vv. 163ff.

215 See A., *Meteora* 1.2.6 (Ed. Colon. p. 23,62-76).

things are ignorant of the natures of things. However, this will be treated in *On Meteors*.²¹⁶ This, therefore, is one of the things that must be said here about fire.

The second, however, is that we find that fire grows strong in the foundations [*radices*] of the earth and that it is contained in the bowels of mountains and in the earth in a combustible matter, which is not suitable to any other element. For water is not contained outside its place in any material, unless it is enclosed in a vessel, and neither is air nor earth, but abandoning everything that is united to them, they rush forth in a rapid fashion and hurry to their places. However, we find that fire is moved downward by following certain materials, and that it burns in them and is not separated from them on account of the contrary nature of the place, until the combustible matter in them is consumed. For this reason some philosophers also said that fire is not an element but that it is generated from motion, not in one place but in every place.²¹⁷ This is false, however, and we already made a determination concerning their error in what has gone before. The reason, however, that fire follows certain materials beyond its own place is that they are homogeneous [*homogenia*] with fire, and they possess a property of fire's place, and for this reason fire is moved to that [property] in them. For on account of its heat it is characteristic of fire to gather to itself homogeneous things, and for this reason it attracts what is homogeneous in these materials, as long as it finds what is homogeneous with it, as place is, and for this reason it divides them and penetrates into them by drawing out the subtle element homogeneous with it. But it is also the cause of this same forceful action of it by which it adheres inseparably to combustible things. The other elements, however, do not have qualities by which they attract bodies to themselves and make them homogeneous with themselves; hence, they always remain opposites, and for this reason they always flee from them and return to their own natural places.

However, what is very wondrous is that there is a certain white stone, called annast, which attracts fire from a very great distance, and fire follows after it and ignites in it. Mendacious priests make lamps for altars with it, which they say are lighted by themselves, and in this way they delude simple people.²¹⁸ But fire follows after white annast whenever it is placed opposite it, whether it be above or below or to the right or to the left, and it is for this reason certain because the rock exhales the spirit of sulfur, as it were, by which spirit fire is attracted in this way to a place that is connatural to it. Not only is it attracted in this way, but the fire is also moved to it as if to a thing in which its natural place exists in some respect, just as a magnet is the place for iron's generation.²¹⁹ And there is a difference between such materials and place, because a thing is generated and

216 See A., *Meteora* 1.2.5 (Ed. Colon. p. 21, 41-22,22).

217 See *supra* 1.1.1 (pp. 21-23).

218 See A., *De mineralibus* 2.3.6 (Borgnet, p. 56).

219 See A., *Phys.* 7.1.3, 8.2.5, 8.4.4 (Ed. Colon. p. 523, 70-524, 16; 598, 26-32; 646, 34-38).

contained in a place, and for this reason natural things are moved to their places as to their principles that generate and contain them. But these materials generate but do not contain [them] in the manner of ones that circumscribe [them], but they retain [them] in the manner of ones that nourish and serve them, like food. These, then, and others of this sort are its properties.

But the statement that there are three species [*species*] of fire, namely, coal, flame, and light was only made concerning fire that exists outside its place, because none of these exists in its place, unless it is said to be light not from the act of illuminating, but from the nature of that which is luminous.²²⁰ For this is a dense transparent [body] and does not differ from one that is not dense by nature but by an accident. We have, however, spoken of this elsewhere.²²¹

CHAPTER TWELVE

AND THIS IS A DIGRESSION EXPLAINING THE MOTION AND THE FLOOD OF FIRE

Let us, however, next speak of the third thing we are investigating concerning fire, namely, the motion and flood of fire. It is, however, reported by philosophers that fire is moved by the sun and that it follows the sun's rays.²²² For just as the moon moves water's moisture, so the sun has to move fire, and the remaining five [planets] have to move the air.²²³ On account of this they say that there are many motions in air, owing to the diverse motions of the five planets, whereas there is one motion in water and one in fire.²²⁴ However, this motion belongs to fire's power [*virtus*] rather than to its substance. For because the sun has an ordered course and does not vary either because of an epicycle or owing to a difference in latitude, since in [its] motion it maintains the ecliptic, which is the middle of the zodiac, there cannot be diverse motions in fire owing only to the fact that fire's property is more and less diffused across the earth with the rays and in the rays of the sun, according to whether the sun rises to the north in the zodiac or descends to the south in the same [zodiac] and according to whether it falls upon the earth perpendicularly with a direct ray or with an oblique one. And it warms more according to whether it is in the lower part of its orbit [*circulus*] than it does in the upper part where part of the diameter [*pars diametri*] is longer, and according to whether it is in the confined space of the sphere of the circle of the signs [of the zodiac] or is distant from that place. For

220 See A., *De caelo et mundo* 2.3.1 (Ed. Colon. p. 144,20-22 with notes 20-21).

221 See A., *De caelo et mundo* 2.3.1 (Ed. Colon. p. 144,9-34).

222 See A., *De caelo et mundo* 4.2.6; 2.3.3 1 (Ed. Colon. p. 265,47-53 with note 48, and p. 147,44-48).

223 See A., *De caelo et mundo* 2.3.3 (Ed. Colon. p. 147,39-44 with note 44).

224 See A., *De caelo et mundo* 2.3.14 (Ed. Colon. p. 175,19-27); *supra* 1.2.10 (pp. 78-79).

in these ways, as we said in the book *On the Nature of Places*,²²⁵ the sun warms more when over one region than when over another.

In sum, there are four modes that the sun alone has, namely, the rise to the zenith overhead, and the rightness of the angle or, generally speaking, the size of the angle according to which its ray falls upon the earth, and the narrowness of the sphere [*artitudo sphaerae*],²²⁶ as when it is under the tropics where the sun remains around the same place for a long time, and the sun's descent to the earth owing to the shortness of the diameter. But from the place where the sun is, it sometimes has the assistance of heat from above, thanks to the hot fixed stars under which it exists, as when it is in Leo and is aided by the star that is called the dog star [*Canicula*], and sometimes it has assistance from the planets and in particular from Mars, which has the greatest heat and dryness.²²⁷ But although Mars is warmer than the sun, moving fire is still not attributed to it but to the sun, and they say that this results from the magnitude of the sun's body and because it is nearer to fire, and for this reason it moves it more powerfully than does Mars. Jupiter, however, also assists, but assists it to burn intemperately, as is the fire of Mars, not [the fire] of Jupiter.²²⁸ Besides, the sun has its own light, which Mars does not have, as will be maintained in the second book of this investigation.²²⁹ But every light is hot with respect to its effect, and if sometimes it moistens,²³⁰ it does not do so insofar as it is light, but insofar as it is the light of this or that body in which it is influenced to produce moisture. Therefore, the sun has to move fire on account of the causes mentioned, and this was not hidden from the ancients, because on account of the four causes that the sun has for moving fire by itself, they gave four horses to the sun's chariot: Pyroun, Eoun, Aethon, and Phlegon.²³¹ But they assigned two wheels to the sun's chariot on account of the orbit bearing the sun, which is eccentric, and owing to its ascent and descent toward the longer and shorter part of the diameter. For although each of these motions exists in the same orbit, the sun still does not have a single power from these two [motions], but two, because running according to the signs [of the zodiac], it looks upon the zenith overhead in different ways, and both descending

225 See A., *De nat. loci* 1.6-7; 1.11 (Ed. Colon. p. 9,81-14,75, and p. 19, 85-91); *De caelo et mundo* 2.3.3 (Ed. Colon. p. 146,50-147,17).

226 "Narrowness of the sphere" seems to refer back to the previous paragraph's "confined space of the sphere," although one might be tempted to read *altitudo* rather than *artitudo sphaerae*—that is, its height, rather than the sphere's confines. Nonetheless the apparatus does not offer this as an alternative.

227 See Plato, *Tim.*, comm. Chalcidius 68 (ed. J. H. Waszink, p. 119, 5).

228 *Infra* 2.2.1 (p. 110).

229 *Infra* 2.1.1 (pp. 98-99).

230 "Moistens": or, humidifies.

231 See Ovid, *Metam.* 2. vv. 153-54.

and ascending to the apogee and to opposition to the apogee, it is raised up and lowered. But both the horses and the wheels cause heat's fire, for which reason moving fire is justly given to the sun. For when it is bright, it heats and when it heats, it sets afire even as far as the innermost parts, and then it cools, calling moisture into itself through the vapors extracted from the innermost parts of things. For this is what the sun's horses mean according to the order enumerated above. But when it moves fire, as we said,²³² it is impossible for it [the sun] to move it to descend downward in a bodily way, since fire is absolutely light and it is characteristic of it to be borne and placed above all things, and for this reason if it descended in a bodily way, this would be altogether contrary to nature. But it moves it so that its heat is diffused in the rays. For this reason some philosophers²³³ said that the sun's rays are warmer than other rays because they pass through fire, although their statement is inadequate because the moon's rays also pass through fire, and yet they are not warm, but cold and moist, as we said above.²³⁴ Let us say, then, that as the sun is hot and dry by effect and not by being informed with heat, so the rays have this in effect, and for this reason it belongs to them to move fire by generating fire in those things in which fire is generated in lower [bodies]. And this way is the one handed down by the philosophers, that fire descends in the sun's rays to the place of generation.²³⁵ Thus it was said how it pertains to the sun to move fire.

There is a flood of fire, however, when the fire that has been called forth by the sun's light dries out and burns the hot climes and does not temper but inordinately warms the cold climes.²³⁶ And this occurs sometimes through a universal cause and sometimes through a cause that is partial. And sometimes a flood of fire is universal across the earth, and sometimes it is particular, as we said concerning a flood of water.²³⁷ However, the ancients did not know the true cause of a universal flood. For Plato said that an orbital deviation of the sun and the planets was the cause of a flood of fire, and he introduces the myth of Phaeton, which Ovid took from the Greeks and brought into Latin,²³⁸ and Plato says that although it seems to be a myth, it is nonetheless a true story. And

232 *Supra* 1.2.11 (p. 82); A., *De caelo et mundo* 4.2.4 (Ed. Colon. p. 261,72).

233 See A., *De caelo et mundo* 2.3.3 (Ed. Colon. p. 147,23-24).

234 *Supra* 1.2.4, 1.2.9 (pp. 53, 76); *De caelo et mundo* 1.1.11 (Ed. Colon. p. 29,65-68).

235 See A., *Meteora* 1.1.12 (Ed. Colon. p. 17,20-26).

236 For a discussion of Albert's role in the debate surrounding this "flood of fire," see Roland Hissette, "Albert le Grand et l'expression *Diluvium ignis*," *Bulletin de philosophie médiévale* 22 (1980): 78-81. This conception was one that Maimonides, whom Albert frequently cites as an authority, condemned. See his *Epistle to Yemen*, in *A Maimonides Reader*, ed. Isidore Twersky (New York: Behrman House, Inc., 1972), p. 455.

237 *Supra* 1.2.9 (p. 71).

238 Ovid, *Metam.* 2. v.179.

these are his words: "Finally, that report which was also made clear to you that a certain Phaeton, the Sun's son, assuming control of [his] father's chariot, rose up to the stars, but not having kept to the appointed courses [*orbiti*] for driving the chariot, he burned things of earth and set them ablaze with celestial flames, is thought to be a myth, but it is a true story; for the orbital deviation of its rotation around the earth occurs over a long interval, which is necessarily followed by a devastating conflagration."²³⁹ However, when explaining these words, some of the ancients said that at times the sun both departs from its customary path and also that the sun's axis is destroyed by the long rotation, and then the sun's chariot is hurled down and comes near to earth and for this reason burns the earth. However, others say that Atlas, who supports heaven's axis, sometimes allows the axis to drop down and sometimes lifts it up, and because of this either immense heat or immoderate cold reaches earth.²⁴⁰

All of these views are false, however, since it has been discovered that the sun never abandons the path that is between each tropic, nor does it drop down more to one of the poles than to the other.²⁴¹ But the variation of ascending upward or descending downward, which occurs in the other planets on account of the epicycle, does not exist at all in the sun, as has been discovered through the most reliable observations of the stars. But the variation that does exist on account of its eccentric [*orbit*] is predictable [*ordinata*], and the sun is moved with that variation every year, and the sun's revolution never approaches Phaeton's star, which shines between the crown of *Adriagna* and *Scorpio*.²⁴² Therefore, that orbital deviation that they describe in mythical terms—that the sun has left the zodiac as far as Phaeton's star—can by no means be true. But the ancients imagined this in error, seeing that they did not know the causes of fiery heat, which the sun produces sometimes. For if the sun's chariot were beyond the zodiac to the north as far as Phaeton and made its circuit, it would not have really reached *Scorpio*, which completes sixty degrees in the south, because if the sun left the zodiac toward the north near *Scorpio*, then it would have completed an entire circuit to the north, and if at that time it had adopted an eccentric orbit in its ascent and descent relative to the earth, it would really have destroyed the entire northern

239 Plato, *Tim.* 22C-D (trans. Chalcidius, ed. J. H. Waszink, p. 14, 6-12).

240 "Others": see A., *Metaph.* 5.5.5, (Ed. Colon. p. 280, 34-52 with notes 50-51); "Atlas": see Ovid, *Metam.* 2. vv. 296-97.

241 See John of Sacrobosco, *Tractatus de spera*, c.3, in *The Sphere of Sacrobosco and its Commentators*, ed. Lynn Thorndike, p. 101, 1-107, 9.

242 "Adriagna" = *Adriadne*. See John of Sacrobosco, *Tractatus de spera*, c.3 (ed. L. Thorndike, p. 97) and Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis Sacrobosco*, lectio 9 (ed. L. Thorndike, p. 175, with note 21); Michael Scot, *Commentarius in Tractatum de spera Iohannis Sacrobosco*, lectio 12 (ed. L. Thorndike, p. 324); and Anon., *Commentarius in Tractatum de spera Iohannis Sacrobosco*, c.3 (ed. L. Thorndike, p. 430, with note 17).

quadrant. And for this reason with the myth of Phaeton the Egyptians did not provide the cause that was the true cause of the fire, but they rather fabricated another cause that they supposed to be true. For the Egyptians wrote many things about the stars in error.²⁴³ For they said that the sun sometimes descends so far that it seems to touch the moon, when it is thoroughly saturated with the Ocean's moisture; and that sometimes it rises up a good distance toward Saturn, when it has raised and lifted itself from the moisture, and that sometimes it stands still over the earth for one or two days, although this only rarely happens. And for this reason they celebrated sacred [rites] of a single sun, a doubled sun, and a tripled sun.²⁴⁴ And the myth expressed this but not the truth of the cause of the matter, in accord with what was discovered later.

However, those who say that the world's axis [*axis mundi*] is consumed have not understood this in a true fashion, because the axis, which is called the *meguar* of the sphere,²⁴⁵ is an intelligible line that cannot be consumed. But rather owing to the sun's gradual ascent above the line and its gradual descent below the line of the world's axis, and when it is lowered and raised up in this way, they say that the axis is worn away. It is also because of this that they say that Atlas sometimes lifts the axis up, and sometimes drops it down below, lying in accord with philosophy and expressing in this way the mode of the sun's course. However, although these are all mythical tales and have some truth,²⁴⁶ because it does not pertain to philosophy to speak in this manner, but rather to speak properly, for this reason they are still dismissed, and the truth is explained as it is.

I say, however, that the cause of the fire is gathered from five causes, that is, from the gathering [*congregatio*] of the sun and Mars and of Jupiter, and from the place of the gathering, that is, so that it occurs in Cancer, between Leo's heart and the Dog, and from the diameter of the sun and Mars, that is, so both of them and also Jupiter is in the lower part of their orbits. And what I said about Cancer I understand with reference not to Cancer's span but to its appearance. Cancer's appearance in heaven is, however, very short, and Leo's heart is not far distant from it on one side, and a certain red star, which is in Gemini and shares the nature and power [*virtus*] of Mars, is on another side, and the Dog [star] is nearby on a third side a little to the south. But although its [Cancer's] appearance is watery because of its very place, because it is one of the small and dark stars, it still does not block much, and on another side it promotes more

243 *Supra* 1.2.4, 1.2.10 (pp. 53, 78); A., *De caelo et mundo* 2.2.5 (Ed. Colon. p. 135, 55-61); Ar., *Meteora* 1.6 (343b4-10).

244 See Seneca, *Naturales quaest.* 1.11.2 (ed. Loeb, vol. 1, pp. 66-67).

245 *Supra* 1.2.9 (p. 73), and note; *De caelo et mundo* 2.1.5 (Ed. Colon. 117, 33); *De animalibus* 1.2.14.303 (ed. H. Stadler, p. 107); *De XV probl.* 5 (Ed. Colon. p. 37).

246 See A., *De caelo et mundo* 2.4.4, 3.1.2 (Ed. Colon. p. 185, 1-6; 204, 58-60); *Metaph.* 11.2.10 (Ed. Colon. p. 495, 79-81).

because the sun fixes its rays there for a long time around the same point on the earth, owing to the narrowness of the sphere, which is the greatest cause of fires [*incendiorum*]. In addition, if at that time the sun is on the lower part of its orbit's diameter, it will be nearest the earth and so too will be the other hot planets, and it will bring about fire, notwithstanding Cancer's nature. Moreover, its appearance is short, to which the appearance of Leo is immediately conjoined, and Leo thrusts its powers upon it, because there is heat in it in the highest state of the fiery triplicity.

But the fourth is that the sun and the hot planets are not blocked by the cold planets, like Saturn and the moon and Venus, and especially by Saturn. And the fifth is that this conjunction occurs with the change of the triplicity of Saturn and Jupiter. For at that time it will produce great events. But although all seven [planets] are perhaps conjoined, if the three that have been mentioned possess [their] powers, they still turn all the others to their properties, and this will occur if the other cold stars [*stellae*] are in the upper part of their apogees, while these are in the lower part, because at that time although Saturn is higher than Jupiter, Jupiter is still larger in size, and the sun is larger in size than any of the others. But this happens very rarely, and for this reason a flood of fire occurs very rarely, and this is what the ancients called a long orbital deviation. For the planets' apogees move by one degree in one hundred years, except the apogee of the moon, and for this reason the sphere moves for a long time before it deviates, so that the three apogees of the hot planets will come together, and I think that this is the true cause of the flood of fire. For that flood has no cause among the lower [elements] as the flood of water did, because the lower elements cannot move fire nor is their vapor material for fire, but rather it is opposed to fire.²⁴⁷ But on the whole the inferior elements are overcome by the superior ones, and the vapor is destroyed. And this is what he [Ovid] said, that "someone or other used evil in it,"²⁴⁸ because Phaeton set the world on fire. For by kindling the light of fire, he illumined it by removing and consuming the vapors. However, if any vapors could perhaps be raised up by the fire, they would be ignited from the fatty and very viscous material, and they would be changed into lights [*candelae*] and burning light beams [*trabes*]²⁴⁹ and a falling star [*assub*]²⁵⁰ and things of this sort, by which almost the entire world seems to be fire, and this is what

247 *Supra* 1.2.9 (p. 76).

248 Ovid, *Metam.* 2. v. 231.

249 *Trabes*: See Seneca, *Naturales quaest.* 7.5.2-4 (ed. Loeb, vol. 2, pp. 236-237).

250 *Assub*: See A., *De caelo et mundo* 2.3.2 (Ed. Colon. p. 144,37 with note); *Meteora* 1.4.4, 6-8 (Ed. Colon. p. 36,38-43; pp. 37-39) and 3.1.5 (Ed. Colon. p. 107,31-32); Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis de Sacrobosco*, lectio 5, in *The Sphere of Sacrobosco and its Commentators*, ed. Lynn Thorndike, p. 166.

the poets intended to say,²⁵¹ [when they said] that an ember of the world's fire reached even as far as Phaeton.

But that fire is removed by two things, of which one is the sun's eclipse and the other is the effect of Jupiter and Mars. For the sun's eclipse occurs only through the interposition of the moon, and for this reason it separates the hot rays from the earth, and then the heat is reduced, and the waters begin to steam and to send vapors into the air, which is tempered by the cold parts rising up to it from the water and earth. And this is why they [the poets] sing in a mythic fashion that Phaeton's father, who is the Sun, grieved over his son's death and withdrew the light for one day²⁵²—not because an eclipse lasts for a day, but because its effect often lasts throughout the day from the darkness cast by the clouds. And no one should be surprised when we say that the eclipse removes the fire since an eclipse lasts but a short while. For it is impossible that all the bodies of that region not be changed toward cold, no matter how briefly the very clear light of the sun is separated from some region, and for this reason the astronomers say that an eclipse's effect lasts for more years than the hours of the eclipse and will perhaps last for periods of unequal length according to the different places of the eclipse. But to know that time period definitively belongs to the science of the stars.

But the first way in which a difference in the fire manifests itself is in the earth's smoke, because although the waters are diminished by the fire and the earth's surface is reduced to dust, it is necessary that a powerful vapor be raised up from the depths of the earth to the upper regions, and once it has been raised up, the vapor is wrapped in watery vapor, and on account of the excessive heat raising itself up, it is kindled, and it causes major lightning flashes and thunder, in which Jupiter furnishes a strong earthy vapor and Mars sends fire.²⁵³ And when the vapor is dissipated and compressed, the lightning [*fulgur*] falls, and the watery vapor that is on the outside is reduced to dew and rain, and then the fire is lessened. And because earth provides the material for this vapor, for this reason they said that earth first raised a clamor with its sacred mouth to Jupiter, who moves the vapor, to preserve it if anything of it was left, lest the whole be burned up. And Jupiter took up the lightning [*fulmen*] and slew Phaeton who set the fire, fighting the fires with fires,²⁵⁴ because the fires of the lightning become enclosed in a watery vapor which trickles down²⁵⁵ after them and extinguishes the things being burned on the earth and in the air.

251 Ovid, *Metam.* 2. v. 231.

252 Ovid, *Metam.* 2. v. 231.

253 See Seneca, *Naturales quaest.* 1.1.7-9 (ed. Loeb, vol. 1, pp. 18-19), 2.41.1-46.1 (ed. Loeb, vol. 1, pp. 166-175); A., *Meteora* 3.3.22 (Ed. Colon. p. 173, 46-47).

254 See Ovid, *Metam.* 2. vv. 279-81.

255 "Ignes distillat": see Seneca, *Naturales quaest.* 2.12.3 (ed. Loeb, vol. 1, pp. 120-21).

These then are the things we have to say philosophically concerning the flood of fire.

CHAPTER THIRTEEN

AND THIS IS A DIGRESSION EXPLAINING FROM WHERE THE RESTORATION OF ANIMALS COMES AFTER ONE OF THE FLOODS

There is, however, a great dispute between Avicenna and Averroes on these floods in their books, concerning what repairs the earth and replaces the animals on it after they have been extinguished and killed by a flood of water and of fire.²⁵⁶

For Avicenna says that the powers of the stars mixed with the powers of the elements form and perfect all things, and only need a female on account of place. And for this reason he says that a 'womb' is required for generation only for the sake of well-being, namely, so that it may be better formed;²⁵⁷ and, because a perfect place for something's generation among the elements is rare, owing to sudden changes of the elements, for this reason nature provides a fixed place, which is the womb of females. But it still often happens that the place for the generation of an animal is at times tempered [*contemperatus*] in the elements, and then he asserts that the stars produce the form for this animal, whose semen has been tempered in the elements.

But he introduces many indications for this, one of which is that we see that mice are generated in one place from the earth, and that later they are reproduced by coition.²⁵⁸

Another indication, however, is that we see that large serpents are generated from hairs and especially from the hairs of women, because by nature they are moister and longer than the hairs of men, and when they are generated, they are later reproduced by coition, and the power of the stars forms male and female in them, as if it had some concern for their posterity.²⁵⁹

256 This debate between Avicenna and Averroes is revisited in Ps. Albert the Great's *De secretis mulierum*. See *Women's Secrets: A Translation of Pseudo-Albertus Magnus's De secretis mulierum with Commentaries*, trans. Helen Rodnite Lemay (Albany: State University of New York Press, 1992), pp. 97-98.

257 See A., *De caelo et mundo* 2.1.2; 2.3.3 (Ed. Colon. p. 107,49-59, and p. 147,69-77).

258 See A., *De animalibus* 22.2.1.123 (80) (ed. H. Stadler p. 1415); Avic., *De animalibus* 15.1 (ed. Venice, 1508, f. 59va).

259 See Avic., *Canon*. 4, fen. 6, 4.51 (ed. Venice, 1507, fol. 479va-b). Ps. Albert the Great reports in his *De secretis mulierum* that Avicenna demonstrated that, if one buries the hairs of a menstruating woman in fertile soil, by spring serpents will be generated from them. See *Women's Secrets*, p. 96.

However, a third indication that proves this more effectively than the things that have been mentioned is that we see that the shape of one animal's head is generated in the womb of another, although the womb ought to corrupt it, even if it is placed there by something, as we see in the births of monstrous offspring, of which we spoke in the second [book] of our *Physics*, and we will discuss more things in the book *On Animals*.²⁶⁰ For one cannot say that this occurs on account of a mixture of the seeds so that one species of animal projects its fluid [*serum*] into the womb of a female that does not belong to its species, because although this occurs in related species, as in the ass and the horse or perhaps the dog and the wolf and ones such as these, it can in no way occur in those that are remote, such as a human and a cow or a human and a pig, although the philosophers still often saw offspring of this sort, as we introduced elsewhere.²⁶¹ Therefore, it follows that the power of the stars forms [them] by the strength of the formative power that they infuse into such births.

However, the fourth indication is that it has been found in the observations of the stars that certain stars impede the formation of a human being, regardless of how effective and well disposed the semen and the womb may be for conceiving, as there are some stars in the sign of Aries that bring about monstrous births, as has often been discovered, and some births of such monsters have occurred among us and have come to our attention.

From all these [indications] and others of this sort Avicenna proves that the first substances of any animal can be produced by the stars and that then they can be reproduced by coition.²⁶² But the myth about Pyrrha and Deucalion also seems to express this.²⁶³ For the earth is the Great Mother whose bones were commanded to lie back, and the bones [are] rocks in which the first mixture of earth with moisture appears, and they were coagulated first as the dry heat extracted the fluid moisture and then as the cold compressed the vaporous moisture in them, on account of which they are icy cold. And they wanted to say that by the mixture of the primary qualities and elements their posterity was left behind them with the power of the stars, which is understood to be the moving [power] in the divinity [*numen*] moving Pyrrha and Deucalion. However, Plato seems to have understood this when he said that the God of

260 A., *Phys.* 2.3.3 (Ed. Colon. pp. 136,13-139,42); A., *De animalibus* 18.1.6.46-54 (ed. H. Stadler pp. 1214-18).

261 See A., *De animalibus* 18.1.6.48 (ed. H. Stadler p. 1215-16.); see *Quaestiones super de animalibus* 18.7 (Ed. Colon. pp. 300,76-301,38).

262 See A., *De caelo et mundo* 2.1.2 (Ed. Colon. p. 107,49-59 with note 59).

263 Ovid, *Metam.* 1.vv. 383ff. See A., *De XV probl.* 6 (Ed. Colon. p. 38, 54-65).

gods, the sower of the universe, created being [esse] and handed it to the stars to embody and complete it.²⁶⁴

These, then, and ones like them are the arguments leading Avicenna to say what he said, that all our dwelling place can be restored by the power of the stars with the mixture of the elements.

But Averroes opposed this, arguing with many arguments that animals that have a great diversity in their members and are called perfect, cannot be restored by the stars and the elements alone.²⁶⁵

And one of these arguments is that the generation of such animals is difficult and for this reason requires a place into which the seed may be cast and coalesce.

But another argument is that if it were the case [that the stars can restore animals], then this would happen often, because such constellations often occur. However, generation such as this is not often observed—or rather it has never been observed—by any of the philosophers or men, who would say that he or one of the perfect animals was produced in that way.

A third argument, however, is that since nature proceeds along the most direct path, it would be better that animals be reproduced in this manner without the mingling of male and female than through the intercourse of male and female; and this does not happen.

But he still objects that according to this [view] there would be no reason [*ratio*] for univocal generation. For equivocal generation would be prior to univocal generation and would be its cause, and according to this the univocal would be reduced to the equivocal. And this is contrary to reason, because the equivocal cannot exist in any way unless the univocal, to which it is reduced, exists first, and it is necessary that the univocal exist before the equivocal.²⁶⁶ Averroes introduces arguments such as these and others similar to them, disproving Avicenna's statement.

264 Plato, *Tim.* 41C-D; trans. Chalcidius (ed. J.H. Waszink, p. 36, 9-10). See A., *Metaph.* (Ed. Colon, p. 34,70 with note, and p. 64,7).

265 Averroes, *Metaph.*, 11(12) comm. 18 (fols. 326D-E).

266 "Univocal" means "having one name." It also implies having some common nature, however. Thus, in the order of causes, univocal causation implies that something is generated from one having the same form, as a human is generated from a human or a tree from a tree. Equivocal generation implies that an organism, for example, is generated from something unlike itself, as, Albert believes, mice might be generated from earth or maggots from putrefying flesh. But if equivocal generation precedes univocal generation in the order of causes, then one could say that "a" is generated from "b" and "b" is generated from "c" and so on *ad infinitum*, never arriving at a definitive cause. Thus, univocal generation must precede equivocal generation, setting a standard against which one can understand equivocal generation, if we are to achieve a science of causes at all.

It seems to me, however, that one ought to agree with each of them in a certain respect, since for the reproduction of plants the moving stars undoubtedly suffice to mix the elements and to form the mixture to this species or that.²⁶⁷ But the same seems to be the case for the reproduction of animals similar in body, as are snakes and worms and fish. For we see that new lakes are produced in which both fish and many kinds of worms are generated by themselves [*per se*]. And animals born from putrefaction, which have no univocal generation, show this too.²⁶⁸

In the same way, however, it seems that one ought to agree that stars have the power to produce animals that are not too dissimilar, such as mice and bats, and any others of this sort that exist in kinds of animals. For although [animals] like these have instruments of motion, like wings and legs, they nonetheless have short and not very different ones. But for the reproduction of perfect animals, like the lion and the ox and the human, they seem to suffice in no way.²⁶⁹ And it is clear that they do not suffice in the human because a rational soul is not educed from matter, but is given by the first giver [of forms] according to the philosophers,²⁷⁰ and for this reason the first human hypostases were created and formed by God without any equivocalness, which John of Damascus says is also the case for other perfect animals that are very different.²⁷¹

But Averroes says that there will never be a flood that is so universal that there is no evasion and no escape.²⁷² Hence it is also said in Plato's *Timaeus* that the Nile and the flooding of the Nile protects Egypt from fire and that very tall mountains defend against a localized flood [*diluvium particulare*], and for that reason other animals are disseminated from those animals that remain.²⁷³

But Averroes says that what is said about the stars is true in similar animals and he says that it is not true in dissimilar animals, because if by chance a shape [*figura*] is impressed by a star on some body or animal, it does not develop the

267 See A., *De veg.* 1.1.7; 4.2.1; 5.1.7; 6.1.21; 7.1.9 (ed. C. Jessen pp. 25; 233; 315; 394; 618-22); *De animalibus* 16.1.8.49 (ed. H. Stadler p. 1085).

268 See A., *De animalibus* 6.3.3.123; 17.2.1.49 (ed. H. Stadler pp. 494-95; 1170).

269 See A., *De caelo et mundo* 2.1.4 (Ed. Colon. pp. 111,71-112,17); *De animalibus* 1.1.3.42 (ed. H. Stadler p. 17).

270 See A., *De caelo et mundo* 1.3.4 (Ed. Colon. pp. 63,92-64,8 and p. 63 note 92); *De anima* 3.2.4 (Ed. Colon. p. 183,32-43). Albert refers to the "giver of forms" [*dator formarum*] also at *Phys.* 1.3.15; 2.2.11 (Ed. Colon. p. 69,15; 118,10).

271 John of Damascus, *De fide orth.* 2.12 (PG 94: 917D-929B). This Greek work had been translated into Latin by the middle of the twelfth century by Burgundio of Pisa, and then by Cerbanus, whose translation was incorporated by Peter Lombard into his *Sentences*. See *De fide orthodoxa: the Versions of Burgundio and Cerbanus*, ed. Eligius M. Buytaert, Franciscan Institute publications, Text series, no. 8 (St. Bonaventure, N. Y.: Franciscan Institute, 1955).

272 See Averroes, *Meteora* 2.1 (fols. 29D-F); *Metaph.* 11(12), c. 18 (fols. 325Bff.).

273 Plato, *Tim.* 22D-23A, trans. Chalcidius (ed. J.H. Waszink, p. 14, 13-15,3).

strength for life, but is dead. For stones are found shaped in a human likeness and likewise monsters, which do not develop a strength for life, which nonetheless must arise from the power of the stars.²⁷⁴

Moreover, although one may speak in this way by agreeing with each of these philosophers in part, it is still not necessary [to agree] for the reason that univocal generation is said to have to precede equivocal generation; for we know that the stars are equivocal generators and they are nonetheless the first generators,²⁷⁵ because they do not generate insofar as they are equivocal, but rather insofar as they agree. For the formative power that is intrinsic to the seed, always agrees with the species and precedes act, just as a confused form and one mixed with matter always [precedes] a distinct form and one existing in act, and generation is produced from the agreement with respect to it. And some things have been determined concerning this in the *Physics*,²⁷⁶ and more will be said in the book on the *Metaphysics*.²⁷⁷

But from the things that have been said what had to be said on the floods of fire and water in accord with the special nature [*proprietas*] of this science is sufficiently clear.

CHAPTER FOURTEEN

AND THIS IS A DIGRESSION EXPLAINING THE PROPERTIES OF EARTH

But many things have been said concerning the properties of earth in the book *On the Nature of Places*,²⁷⁸ and in general only a few things remain to be said, namely, that earth is an element that does not have any local motion by the power of the stars, as the other elements do. And the reason for this is that because the earth is the last moveable, it cannot participate in moving owing to its distance from the first cause, as was determined in the second book of *On Heaven and Earth*.²⁷⁹ But because the earth is at the center of the whole universe [*mundus*], it is necessary that all the rays of the starry sphere [*orbis*] be united on it, whose center it is. For this reason it has to be moved according to nature by the very sphere of the fixed stars to the shapes of the fixed stars, and because that sphere has many images, the earth is for this reason susceptible to many shapes—shapes that are varied by the shape of the images and by the

274 See A., *De mineralibus* 2.3.1-2 (Borgnet, pp. 48-51).

275 See A., *Metaph.* 8.2.3; 7.2.9 (Ed. Colon. p. 404,90-95; 351,51f. with notes 53-54).

276 A., *Phys.* 1.3.3, 1.3.11 (Ed. Colon. pp. 40,73-44,86; 57,20-60,58).

277 A., *Metaph.* 7.2.9 (Ed. Colon. p. 350,62f.).

278 See A., *De nat. loci* 1.3, 1.6 (Ed. Colon. pp. 5,18-6,7 and 9,47-12,31).

279 A., *De caelo et mundo* 2.3.14; 2.4.8 (Ed. Colon. p. 174,59-63; 175,27-30; 195,25-28).

manner of the diversity of the rays, which are varied by the rising and setting of the stars over the earth.²⁸⁰

And this is the reason that earth produces such multiform variations, which no other element does, in which the celestial rays are not collected at one point. For all the lines coming from the circumference are only united in one point at the center, and this is why the rays, which are like lines of celestial light, have almost their entire effect on earth, which is the perceptible center of the sphere.

However, there is another cause for this, namely, that none of the elements except earth entirely reflects the rays but earth. For water reflects [them] in some manner, but not entirely, because they pass through to the bottom of the water. Earth, however, stops them entirely at its surface and reflects them. Therefore, since a ray only exists in its power where it is reflected, it can only produce the shapes of the species adequately in earth on which its rays are reflected and multiplied.

Still, however, the moist is capable of receiving forms but not of retaining them.²⁸¹ But fire's dryness does not sit still to receive forms, but evades [them] with its mobility. It remains, therefore, that immoveable dryness is capable of retaining shapes, but it does not easily receive them. And for this reason the cold earth is inundated with water is so that it is softened in order to receive and retain forms and shapes.

Still, however, when it [earth] receives fluid moisture, it does not resist things that alter it, but the hardness retains the earthy dryness, because it has a natural power [*potentia*] not to yield to that which touches it or alters it, whereas the moist softness lacks the power, and this is why if the forms given by nature have to endure, it is necessary that an earthy dryness receive them as a subject, on which they are first impressed by nature properly and essentially [*per se*]. But earth is an element that neither causes a flood nor evaporates by itself without moisture. For it is only necessary to have as much moisture as suffices for its continuation, and without this it is reduced to dust and will not evaporate, just as ash does not, and this is why it cannot have a flood. Earth is also said to be the Great Mother owing to the abundance of earthy matter in every composite, because she conceives the seeds of all things in herself. For it is necessary, as we said above, that the power of all movers be gathered in the last moveable, and this is why the seed of the whole of nature exists in earth.

But why any part of the earth follows because of the longitude from the east and the latitude from the north, was discussed sufficiently in the book *On the*

280 See A., *De caelo et mundo* 2.4.8; 2.4.2 (Ed. Colon. p. 195,50-84; 182,4-34).

281 See A., *De gen. et corr.* 2.1.5; 2.1.7 (Ed. Colon. p. 181,3-14. and 181,49-182,90); At *Quaestiones super de animalibus* 15.11.2 (Ed. Colon. pp. 265, 69-266,30), A. explains that the moist easily receives impressions—just as one can easily make impressions in the mud—but that they are not retained or preserved, but easily erased. Since women generally have a moist complexion, this principle allows him to explain his contention that women are more inconstant and fickle than men.

Nature of Places,²⁸² because it has a change of heavenly shape depicted at the horizon from the longitude, and it has a different disposition of hotness and coldness, of moistness and dryness from the latitude.

These things, then, have been said concerning the natural properties of the elements. We will, however, explain their accidental properties next, making another beginning for the book.

282 A., *De nat. loci* 1.9 (Ed. Colon. pp. 15,88-17,32).

HERE BEGINS THE SECOND BOOK

ON THE CAUSES OF THE PROPERTIES OF THE ELEMENTS,
WHICH CONCERNS THE ACCIDENTAL PROPERTIES OF
ELEMENTS

TRACTATE ONE

ON THOSE THINGS THAT HAVE TO BE SET FORTH FIRST
CONCERNING HEAVEN AND THE POSITION OF THE EARTH

CHAPTER ONE

ON THE ELEMENTS COMPOSING HEAVEN

In this second book on the causes of the properties of the elements we direct our attention, explaining whatever properties there are that alter the nature of an element, which some call corruptions of the elements, although improperly.²⁸³ For heat and cold can be added to elements apart from their nature without their substance being corrupted as a result.²⁸⁴ Therefore, intending to explain the nonnatural qualities of elements that they sometimes acquire, we will only introduce the simple qualities that either do not produce a mixture of an element or do not produce one that draws the element beyond [its] substance and nature. We will discuss mixture in another book.²⁸⁵ But we will explain here the qualities that [come] either from place or from some moving heavenly body. We cannot do this properly, however, unless we first consider certain qualities of the noble element, which is a celestial body, showing in accord with which and how many powers in their kind it moves the inferior elements. For from this those things that were said in the previous book are more easily understood.

I say, then, that it is necessary that the nature of the entire sphere is either simple,²⁸⁶ containing within itself only those things that are homogenous, which are of one form and one disposition and power, as every part of fire is fire;²⁸⁷ or it

283 See A., *Phys.* 7.1.6; 8.3.1 (Ed. Colon. pp. 528,80-530,65; 618,14-622,39); *De gen. et corr.* 1.2.1-4 (Ed. Colon. p. 136,13-138,37).

284 See A., *De gen. et corr.* 2.1.7, 12 (Ed. Colon. p. 181,49; 185,33-54).

285 A., *De gen. et corr.* 1.6 (Ed. Colon. pp. 169,21-176,28).

286 A., *De caelo et mundo* 2.3.4 (Ed. Colon. p. 149,46).

287 See A., *De caelo et mundo* 3.2.9 (Ed. Colon. p. 244,45-46).

has a composite nature, having within itself things that are different in terms of form and disposition.²⁸⁸ However, we see with our eyes that the sphere does not have one nature and one form and disposition, since there exist in it both diverse spheres and diverse parts, of which one is a star and another does not receive light, but is a part of heaven not having light, and such a diversity of forms and dispositions does not exist in that which has a simple and homogenous nature.²⁸⁹ Let us assume then that the entire sphere is composed from parts that are diverse in form, and let us call these parts the elements that compose the sphere, since in accord with reason they are the ones that compose the sphere first.²⁹⁰ For according to reason the homogenous is prior to the heterogeneous and is the element that composes it. And if what is heterogeneous is resolved in terms of the intellect [*secundum intellectum*], it will be resolved into homogenous [parts or elements]. But if it is not possible to resolve these further into other bodies in terms of form, they will be called the elements of that heterogeneous body.²⁹¹ In heaven, however, homogenous [parts] cannot be resolved further into others with respect to form; therefore these, however many there are, will be the first elements of the sphere, from which it is composed according to reason, which reason is the resolution of a composite into simples, although it is not composed in terms of being [*esse*] because it is not subject to generation and corruption, as we showed elsewhere.²⁹² Therefore, those elements are either one, or two, or three elements, or more according to some determinate number, since nothing that is finite is composed from an infinity, as we showed in the *Physics*²⁹³ and in the first [book] of *On Heaven and Earth*.²⁹⁴

Let us say, then, that if we want to investigate the first components of the sphere, which are called elements, we will say that a substance that gives light by itself [*per se*] is different with respect to form from one that is made light-giving not by itself, but by another. But each of these is still different from one that is not at all illuminated in order to give light. For these three variants exist in every sphere, and this is why the composition of the sphere out of these three is [a composition] of the first elements of the sphere.

288 See A., *De caelo et mundo* 2.3.15 (Ed. Colon. p. 177,60-64).

289 See A., *De caelo et mundo* 2.3.1 (Ed. Colon. p. 142,1-58).

290 See A., *Metaph.* 1.5.3 (Ed. Colon. p. 72,8-10).

291 See A., *De caelo et mundo* 3.2.1 (Ed. Colon. p. 220,21-27).

292 See A., *De caelo et mundo* 2.3.4; 2.2.6; 2.1.1 (Ed. Colon. p. 149,46; 138,14-39;104,7-10).

293 A., *Phys.* 3.2.5-6 (Ed. Colon. pp. 178,32-182,14).

294 A., *De caelo et mundo* 1.2.2 (Ed. Colon. pp. 34,32-38,34).

However, from what we proved in *On Heaven and Earth*,²⁹⁵ we say that in accord with this the substance of the sun's body is different from the substance of the body of the stars and of the moon with respect to form and disposition. The proof for this is that it is called the sun [*sol*] because it alone [*solus*] gives light; it possesses light from itself.²⁹⁶ The moon and the other stars, however, only have the light that is acquired from the sun, as we showed in other places in the book *On Heaven and Earth*.²⁹⁷ But although all the stars receive light from the sun, there is still a great diversity among them, because the moon has a more earthy nature,²⁹⁸ and this is why a shadow appears on it, which does not happen on the other stars.²⁹⁹ And the fact that the stars are not shaped by the shapes of the moon for the reception of light is due to the fact that many of them are above the sun, and for this reason the one surface that is turned toward the sun and toward us is always illuminated. However, this does not happen in Venus and Mercury, stars that according to many people³⁰⁰ are below the sun, because they are not on paths that go directly under the sun and because they are near to the sun and far from us. For if they were on a path that goes directly under the sun, they would sometimes eclipse the sun, which can never happen. Still because they are near the sun, they are, however, immediately filled with the sun's light, and because they are more remote from us, they are purer luminaries than the moon, and this is why they are penetrated with light throughout their entire substance, from one surface to the other surface through the center of their bodies. This is why on whatever side a solar ray touches them, they are immediately filled with light, which does not happen to the moon owing to its natural opacity and earthiness. For although it receives light into its depth, it is nonetheless not penetrated by the light, but it sinks into it up to its middle center

295 A., *De caelo et mundo* 1.1.11; 2.1.7; 2.2.5; 2.3.3 2 (Ed. Colon. p. 29,22-44;124,60; 136,86;145,85-86; 147,23-68).

296 See A., *De caelo et mundo* 2.3.6 2 (Ed. Colon. p. 154,6-7 with note).

297 See A., *De caelo et mundo* 1.1.11; 2.1.3; 2.3.6 (Ed. Colon. p. 29, 53-70. with note 69; 107,34-48; 154,19-71).

298 See A., *De caelo et mundo* 1.1.5; 2.2.3; 2.3.6; 2.3.8 2 (Ed. Colon. p. 16,34-36; 132,71-72; 154,47-49 with notes 48-49; 160,13-14; 168,69-73).

299 See A., *De caelo et mundo* 2.3.6 2 (Ed. Colon. p. 154,43-57). This 'shadow' on the moon seems also to be an indirect reference to the "spot" or image on the moon, popularly called the "man in the moon." See Robertus Anglicus, *Commentarius in Tractatum de spera Iohannis de Sacrobosco*, in *The Sphere of Sacrobosco and its Commentators*, ed. Lynn Thorndike, lectio 15, pp. 197-98. For a discussion of medieval debate on the "spot" on the moon, see Pierre Duhem, *Medieval Cosmology: Theories of Infinity, Place, Time, Void, and the Plurality of Worlds*, ed. and trans. Roger Ariew (Chicago and London: University of Chicago Press, 1985), pp. 483-97.

300 See Al-Bitrūjī, *De motibus celorum* 16, 1, ed. F.J. Carmody, p. 127, A., *De caelo et mundo* 2.3.11 (Ed. Colon. p. 168,19-73).

point. Those men who excel in philosophy, namely, Aristotle and Ptolemy and Avicenna and Messealach³⁰¹ and many others, are in agreement on this matter.³⁰² Therefore, these two elements have diverse forms, which are found in the first components of heaven.

As a result, it appears quite clearly that the substance of the body of the stars and of the moon is different from the substance of the sun's body. For as a candle illuminates a mirror by the substance of the light that is in it, and the mirror receives this by the substance and form of the stopped transparent [body] that is in it, and as the candle's substance is different from the mirror's substance, so it is necessary that the substance of the sun that illuminates be different from the substance of the moon and of the stars that are illuminated. Nonetheless, in this analogy there is this difference that a mirror only receives light that is extinguished and stopped [*terminatum*] on the surface of something polished and diaphanous, not passing on what is seen. But the stars and the moon receive light into their depth, as we showed in the second book of *On Heaven and Earth*.³⁰³ Therefore, from what has been said it is clear that the sun's substance is one thing and the substance of the moon and stars is another.

But a similar argument proves that the starless substance of the sphere has a substance different from the stars and the moon with respect to form,³⁰⁴ since although the starless part of the sphere is illuminated by the stars and the moon, it nonetheless does not retain the light in itself like a luminary,³⁰⁵ but receives it like air and every other diaphanous body through which the light passes and does not remain in it. On account of this a star covers and conceals what is behind it, as the moon does, which sometimes covers the sun and frequently covers the stars. However, the starless part of the sphere does not cover any of those that are behind it, but vision passes through it as through air or another diaphanous thing. For otherwise it would be necessary that we see none of the higher spheres, but only the sphere of the moon, which we experience with our own eyes to be false. Therefore, the starless part of the sphere is of a different substance from the moon and the stars with respect to form and property. And by the same reasoning the same starless part of the sphere is proven to be different from the sun with respect to substance, since the sun gives light by itself

301 I.e., Māshā'allāh (d. 815), who was an influential Persian Jewish astrologer and astronomer from Basra in Iraq. In the twelfth century, his popular *De ratione circuli* was translated into Latin by John of Seville and his *De scientia motus orbis* was translated by Gerard of Cremona.

302 See A., *De caelo et mundo* 2.3.5; 2.3.6 (Ed. Colon. p. 151,66-74; 153,79-82); Al-Bitrūjī, *De motibus celorum* 7, 12; 16.10-13, ed. F.J. Carmody, p. 90 and pp. 128-29.

303 A., *De caelo et mundo* 2.3.6, 2.1.2 (Ed. Colon. p. 154,19; 107,34-48).

304 See A., *De caelo et mundo* 2.3.4 (Ed. Colon. pp. 148,91-149,37).

305 See A., *De caelo et mundo* 2.1.2 (Ed. Colon. p. 107,42).

[*per se*] and covers that which is behind it and stops vision. But a part of the sphere does not in any way give light or cover what is behind it, and it brings vision [*visus*] through it.

Therefore, from these principles and through this investigation it is clear that the entire sphere has three primary substances, which, because they are the first components, are called the three elements that compose the sphere, as uniform members compose those that are not uniform.³⁰⁶ In this composition, the sun is a substance by itself [*per se*], and the moon with the stars is a substance by itself, and the part of the sphere that is starless is a substance by itself. And the sphere has more remote parts that differ in species, as we said in the second book of *On Heaven and Earth*.³⁰⁷ But these three substances are first in the sphere according to nature, and for this reason they are called elements. If, however, we designate the sphere by a common nature, according to which it is a substance that is not subject to generation and corruption, existing in potency only for local motion, then in this respect all three of these will have one nature and substance in common, and if that should be called an element, then the entire sphere will be one element, which is said to be a fifth element distinct from the other four. For although the sphere is not mixed from those compounded from elements through [its] substance and being, in producing a mixture, it is itself still the first agent whose power is also in those things that are mixed, and to this extent the definition of an element belongs to it since it is itself effectively first in composition;³⁰⁸ and if that which is compounded from elements is resolved, not into mixed substances, but into the powers that something mixed has, the first power of the sphere will be found in it.

Therefore, by distinguishing the sphere from the four elements in this way, it is called the fifth element, because it differs from them in the nature of its form and in the kind of its matter and potency; and of what sort it is is explained at the end of the first book of the *Physics*.³⁰⁹ For we do not say that it is absolutely light so that it is fire, nor do we say that it is absolutely heavy so that it is earth, and it is self-evident to anyone that it is not light or heavy by a comparison, as the middle elements are. For if it came from one of these elements or were one of them, it would be generable and corruptible either according to the whole

306 See A., *De animalibus* 1.1.1.4 (ed. H. Stadler, p. 2). A. defines a uniform member as one that, when divided into parts, its parts all reveal the same nature or appearance. For example, flesh is a uniform member, and bone is another. When one cuts off a piece of flesh, it is indistinguishable from some other piece of flesh, except in terms of size or dimension. It displays instead uniformity. By contrast, a hand or foot is a non-uniform member that is composed from one or more uniform members. When one divides a hand into parts, the various parts cease to be a "hand."

307 See A., *De caelo et mundo* 2.3.4 (Ed. Colon. pp. 148,91-150,46).

308 See A., *De caelo et mundo* 3.2.1 (Ed. Colon. p. 220,25-27).

309 A., *Phys.* 1.3.11; 1.3.18 (Ed. Colon. p. 57,20-60,58; 75,40-76,67).

or according to the part, falling under generation and corruption. And this [generation and corruption] is not found in it, but instead the highest Creator, the Lord of heaven and earth, established it so that by its motion it is the cause of all generation and of all corruption, as we showed at the end of the second book of *On Generation and Corruption* [*Peri Geneseos*].³¹⁰ Therefore, let so much be said on the number of the elements of the sphere.

CHAPTER TWO ON THE WORLD'S FINITUDE

In this book, however, we cannot know the size of the celestial bodies, because their size is known from the size of their diameters, and this will be investigated in the *Astronomy*,³¹¹ where the proportion of the stars to one another has to be determined as well, since they all have to be reduced to six sizes.³¹² And there too the size of the revolution of each sphere will be determined as well as how far its lines extend from the center of the earth. And certain demonstrative syllogisms drawn with visible lines will be introduced concerning this. However, we do not now want to explain anything more about the sphere except what we said about the first [elements] that compose it.

Since, then, we have already said what we want to say about the nature of the sphere, let us now speak against those who say that the sphere is infinite with respect to its ends [*secundum ultima*]. For we have already shown in *On Heaven and Earth*³¹³ that the four elements, namely, earth and water and air and fire, are finite with respect to their ends. For each of them has its furthest extremity in a place below around the earth, and this is evident to sense experience. However, every natural body that has one extremity also has a second by which it is limited on its other side. But we see that the earth is bounded by a finite surface in a convex arc,³¹⁴ and we see that air and water are bounded by finite surfaces in a concave arc. Therefore, each of these bodies is also limited on the other side in a concave arc or a convex arc, since otherwise it would be imperfect, and nothing would be joined to it in place, but it would occupy [space] to infinity.³¹⁵ However, whatever is enclosed between two extremities, of which one is concave and the other round or convex, is finite. Therefore these elements are finite, and the heaven, whose concave arc we see, is finite. However, our opponent says that the

310 A., *De gen. et corr.* 2.3.4ff. (Ed. Colon. pp. 203,64-206,69).

311 See A., *De caelo et mundo* 2.2.3; 2.3.11; 2.3.12. (Ed. Colon. p. 132,88 with note; 165,67-68 and 167,84; 169,85 and 170,25).

312 See A., *De caelo et mundo* 2.3.11 (Ed. Colon. p. 167,43-46).

313 A., *De caelo et mundo* 1.3.6; 3.2.2 (Ed. Colon. p. 69,27-34; 221,32-224,35).

314 Presumably, looking out toward the horizon.

315 See A., *De caelo et mundo* 2.2.3; 1.1.5 (Ed. Colon. p. 130,81-133,5; 14,61-71 with note 68).

heaven is not finite and that the elements are not finite; and this is impossible, because it is not suitable for that to exist in a natural body.

Besides, let us ask them whether the fifth element is in motion or at rest. But one cannot say that it is at rest, because this is contrary to sense experience and contrary to what was proved in the *Physics* and in the book *On Heaven and Earth*.³¹⁶ Therefore, it is moved by a circulating motion that is called revolving. However, such motion is over a mid-point, which is the center, and above two poles, namely, the south pole and the north pole. Therefore, it is necessary that its concave arc complete its circulation around the center in a certain period of time. But when its concave arc completes its circulation, then the convex arc also completes a larger circulation around the same center.³¹⁷ Therefore, the circulation of each is completed in the same time. But that which completes a circulation in a certain finite time is finite; therefore both the convex [arc] and the concave [arc] of heaven are finite. It follows from the fact that it has a center mid-point. For this is clear from sense experience. It is necessary then that it have a concave and convex revolution around that which is its two extremities. For it is necessary that everything that has two extremities be located in place and be finite in place. But although highest heaven is the place of all things, it nonetheless is related to place by the fact that it is moved in terms of a finite place, as we said at the end of the sixth book of the *Physics*.³¹⁸ It is clear then that the world has a mid-point, and everything that has a mid-point, which is a center, has two extremities of concave and convex arcs. But everything that has two extremities has an end, and everything that has one extremity also has another extremity. From the things that have been said it is, therefore, clear that the world is finite and, consequently, the error of him who says that the world is infinite is apparent.

But although we have proved this in *On Heaven and Earth*,³¹⁹ it was nonetheless necessary for us to introduce a brief proof for it here, because if the world were infinite, there would not be a property caused in one element by another [element], because what is infinite neither acts nor is acted upon, as was proved elsewhere.³²⁰

316 A., *Phys.* 8.2.5; 8.2.8 (Ed. Colon. pp. 596,38-598,74; 605,81-607,61); *De caelo et mundo* 1.1.3; 2.3.1 (Ed. Colon. p. 9,14; 143,1-5; 128,11-80).

317 See A., *De caelo et mundo* 1.2.2, 1.2.2 (Ed. Colon. p. 36,61-70 and 38,23-26).

318 A., *Phys.* 6.3.5 (Ed. Colon. pp. 496,20-497,86).

319 A., *De caelo et mundo* 1.2.2 (Ed. Colon. pp. 33,5-38,35).

320 A., *Phys.* 3.2.10 (Ed. Colon. pp. 187,15-189,20).

CHAPTER THREE

ON THE REFUTATION OF THE ERROR OF THOSE WHO SAY
THAT THE EARTH IS

HIGHER IN THE SOUTH THAN IN THE NORTH

Next it is necessary for us to inquire whether the earth is at the center of this body. For some of the ancients have said that the earth's southern side is elevated and that its northern side is lowered and contracted from the center so that the [earth's] southern part is nearer to the south pole and the northern part is longer than the radius of the sphere, and that the part of the line that is between the earth and the pole on the south side is less than the radius of the sphere. And they say that the authority of the ancients is an indication of this. For they said that one of the ancient kings, who was concerned with the good of the community, wanted to create a deep channel connecting two seas, namely, the Red Sea, which is the sea of Egypt, and the Wide or Great Sea,³²¹ which is the sea of the land of the Romans, which in Arabic is called *Sceny*, so that through that canal navigation would be uninterrupted from the land of the Romans to the land of Adramoth and to the land of Iamen,³²² which belongs to India, and contrariwise from the land of those parts to the land of the Romans. And ships would pass without interruption to the Persian Sea, which is joined to two islands that are called Dalely and Alcause,³²³ and to the lands that are there, and through it commercial activity would be greatly facilitated. However, when the king was considering how to accomplish this, a certain geometer prevented him, and the sages agreed that his prohibition was proper and appropriate because they said that with an instrument that sage had taken the elevation of the Red Sea, which is to the south, and also the elevation of the Great Sea, which is to the north. But he took it by the size of the diameter that existed between the surface of the sea and some celestial body, because if he had taken [the measurement of] the depth of the sea, he would have done nothing for the proposed task, since from the fact that one sea is deeper than another with respect to depth it does not follow that one will completely flow into the other. But if the bottom and the water [level] of one sea is elevated above the bottom

321 This Wide Sea—*mare Expansum*—is further identified as the *Scemi/Sceny*, which Vodraska (DCPE, p. 171) identifies as the Mediterranean Sea.

322 Vodraska (DCPE, pp. 292-293) identifies *Hadramot/Adramoth* as the southern area of the Arabian peninsula, and *Iamen* as the south-east part of the Arabian peninsula. See above p. 45 and note 86.

323 Vodraska (DCPE, pp. 291 and 284-85) is unable to identify the island of *Dalely/Daleli*, but notes that from its association with *Alcause/Alcaulem*, present-day Quilon on the south-eastern coast of India, one may surmise that both islands are located in the Indian Ocean.

and the water [level] of the other, then the higher one will flow into the one that is lower, if there is no impediment. Therefore, since through consideration he discovered that the Red Sea is elevated forty stadia above the Great Sea, insofar as a stadium is taken to be eight hundred cubits, the bottom of the Red Sea was that much higher than the bottom of the Great Sea, and for that reason the entire Red Sea would have flowed into the Great Sea and would have submerged the cities that are upon the shores of the Great Sea from each shore. And Alexandria and Damat and Tunix³²⁴ and Alfaritie³²⁵ and the island of Crete and Corsica and Mallorca and Sardinia and the other islands of the Great Sea—which are approximately forty-seven islands—would have been submerged,³²⁶ and in this way many good regions would have been submerged. Therefore, after this sage explained to the king such great damage [that would result], he abandoned his intention. Therefore, relying on this authority, they say that the earth is higher in the south than in the north.

However, let us speak against them with a sure doctrine and with a geometric syllogism, saying that if a channel had been dug from the Red Sea to the Great Sea, as much water would have gone out from the Red Sea as to inundate the shores of the Great Sea, as the opponent says. But the channel dug by the king would not have been wider and deeper than the channel of the Nile which, coming from the south, nonetheless enters the Great Sea and has flowed into it for many years and even for many thousands of years. Let us ask, then, whether the Nile has added anything to the sea over so many years and especially when it is swollen and floods when the sun is in Capricorn, when it begins to retreat from the south and to come to the north. It is evident, then, that they cannot but say that it has made a great addition to the Great Sea and one much greater than the channel that the king wanted to dig would have made. If what the opponent says were true, then many of the cities listed above would have been destroyed on account of the additional water and many of the islands listed above would have been destroyed.

In addition, however, since a great deal of water enters the Great Sea from the eastern and southern part of the Ocean containing it, and likewise from the western part, massive flooding ought to have occurred for a very long time in the Great Sea. But we never saw anything of the sort. Therefore, it is clear that

324 Vodraska (*DCPE*, p. 291 and 297) identifies *Damat/Damiat* as Damietta, on the Mediterranean coast of Egypt, and *Tunix* as a town in north Egypt. Perhaps *Tunix* = Tanis?

325 Vodraska (*DCPE*, p. 286) identifies *Alfaritie/Alfarne* as the ancient Pelousion/Pelusiam, near the Mediterranean coast of Egypt (and about 20 miles east of modern Port Said); it was reputed to contain the tomb of Galen.

326 Note that A's received text identifies fifty-seven, and not forty-seven islands, of the Great Sea.

the contrary of what the opponent said is true, which he confirmed by the great sage who measured the earth.

However, only the inhabitants of Egypt and of the regions through which the Nile flowed were of this opinion. And the reason for their error was that they saw that all water flows to a low point, and because they saw the Nile coming from the south to the north, they thought that the southern part was high and that the northern part was low, and this was a false indicator, because according to this [indicator] the northern part too would be high and the southern part would be low. For according to this [indicator], those who dwell upon the banks of the Tigris and Euphrates, which flow from north to south and empty into the Persian Sea, would have to say that the northern part is elevated and the southern side is depressed. For the source of the Tigris is from a mountain of Armenia to the north, and the source of the Euphrates is from the land of Alcharar,³²⁷ which is India, and they empty into the Persian Sea. Therefore, it is necessary that something like what they feared would happen in the Great Sea, would happen in the Persian Sea from the influx of the Tigris and Euphrates and from the large quantity of their water. But it never happens. We will say in the book *On Meteors* why the seas do not overflow from the entrance of many rivers into them.³²⁸

Therefore, it is sufficiently clear from what has already been said that it is an error to say that the earth is elevated in one part and depressed and contracted in another part. For there is a center for the world, as was proved in the book *On Heaven and Earth*,³²⁹ and, as existing in the middle, it contains air equally from every side with the convex surface of the water and the concave surface of fire.

327 Vodraska (DCPE, p. 285) identifies the "land of Alcharar/Alcharar" as the Khazar kingdom, located between the Caspian and Black Seas north of the Kurr River and the Caucasus Mountains. But based on this identification, he admits that the statement that the Euphrates originates there is strange.

328 A., *Meteora* 2.3.11 (Ed. Colon. pp. 93,50-94,9)

329 A., *De caelo et mundo* 2.4.8 (Ed. Colon. pp. 193,19-195,84).

TRACTATE TWO ON THE CORRUPTIONS OF THE ELEMENTS

CHAPTER ONE ON THE CORRUPTION OF AIR BY THE VAPORS OF LOWER [BODIES]

But after we have set forth what is necessary for knowing the corruption of the elements, let us treat the corruption of the elements. For the four elements, which are earth and water and air and fire, are corrupted according to their qualities. For we sometimes perceive corruption in them. For the air is sometimes cooled more than it ought to be and warmed more than it ought to be. But sometimes it is moistened more than nature requires, and sometimes it is dried out more than is necessary. In the same way, however, water is cooled and warmed beyond what it ought to be. However, sometimes sweetness and bitterness and saltiness and things of this sort are also added to water. But we will not treat these things here, because these are not added to simple water but to water that is mixed with other elements. Earth, however, is cooled and warmed more than it ought to be and receives other corruptions. All these things should be treated in order to know the cause of these corruptions. However, because fire does not receive any corruption, since it consumes by its intense heat every corruption in itself, for that reason, having set aside fire, which is the highest element and first in place, let us speak about air.

Air, however, is corrupted in two ways, namely, sometimes because of some lower [body] poisoning and corrupting it, but sometimes from a higher heavenly body that corrupts it. [It is corrupted] by some lower [body], for example, from the breath of poisonous animals, to which corruption is similar that which stems from a poisonous vapor, from a corpse or a swamp or anything else that has decayed, for which we will submit one example for the sake of understanding all others. For in the days of king Philip, the king of Macedon, who was called Philip the Bold³³⁰ and was a philosopher, and especially an astronomer, and who was the father of Alexander the Great, there was a path between two

330 For Philip the Bold, see A., *Super Dionys. Epist.* 11. s.v. *Philipus Aridaeus* (Ed. Colon. p. 553,36 with note); for Philip of Macedon, see A., *Meteora* 2.2.17 (Ed. Colon., p. 81,1). A. seems to have confused Philip of Macedon and his son, Philip Aridaeus. The latter was Alexander the Great's brother.

mountains of lesser Armenia,³³¹ which was frequented in good health for a long time by many travelers. However, it suddenly happened that no one could travel on that path without expiring and falling dead on the mountain because of poisonous air. When Philip asked the sages for the cause, they did not know how to explain the cause, until Socrates was called, who made the king erect a tall building equal [in height] to the mountains.³³² And Socrates made a flat mirror of steel that was neither convex nor concave, but had a flat surface that was well polished and well cleaned, so that a reflection would be produced on the flat surface from every place on the mountains. It could not have been made convex because on a convex [surface] a reflection is produced only from a determinate distance and opposition, but on a flat surface a reflection is produced from every place that is below, above, and opposite it, and objects will be reflected in it according to their true size. Moreover, he placed the flat mirror opposite the place of the mountain, and in it he saw two dragons, large dragons with respect to their kind, one on one mountain and the other on the other mountain. For there is a long serpent [*serpens cubitalis*] that is called a dragon and has a deadly bite and poison.³³³ But if they had been very large dragons, as some imagine³³⁴ that dragons are the largest animals that are found, Socrates would easily have seen them without the mirror. But these dragons opened their mouths opposite one another and infected the air in between with a vapor from their stomach, which emerged from their throats. And while Socrates contemplated them in this way, some cavalrymen who were unaware of the danger traveled past and fell dead from the beasts because of the poison that had been diffused through the air. From this he knew that the infection was caused by the vapor released from the dragons' stomachs, and he quickly reported this to the king. However, the king commanded that someone should go forth and slay the dragons, with his mouth, nose, and all his pores through which the infected air could be drawn in covered. Once they were slain, the place was made safe so that what had happened there no longer happens, and the king was astonished at Socrates's industry and wisdom. However, the corruption of the air stemmed from the vapor released from the dragons, just as water is also infected from the corruption of henbane when it is cast into ponds or rivers.³³⁵ For when the henbane begins to putrefy,

331 Lesser Armenia was a portion of historic Armenia that lay west of the Euphrates River, which emerged as independent from Greater Armenia after the campaigns of Alexander the Great.

332 The author of A.'s received text wrongly assumed that Socrates (d. 399 BCE) was still alive during the reign of Philip II of Macedon (382-336 BCE), Alexander's father. This discrepancy is another indication of confusion over the identities of Philip of Macedon and Philip the Bold.

333 See A., *De animalibus* 25.25(27-29) (ed. H. Stadler pp. 1565-1567).

334 A., *De animalibus* 25.26(27) (ed. H. Stadler p. 1566).

335 See A., *De veg.* 6.2.10 (ed. C. Jessen pp. 526-27).

it infects the water and becomes obstructive [*oppilativa*] so that that fish and other aquatic animals attempt to leave the water and wander in the water as if they were drunk. This, nevertheless, happens more in air, because on account of its natural heat, air corrupts more than water, which checks [henbane's corruption] a little bit with its coldness and does not permit it to putrefy so quickly and so powerfully.

But this plant generally has three colors on its root, that is, black, red, and white. And the flower of the black one is as if sprinkled with the color of blood; the flower of the red one is yellow, and the flower of the white one is white. And it is the black one that has the effect that is described here. It works effectively, and next after this one comes the red. However, the white one does not do this, unless there is a great quantity of it, for it is very cold and dry. And this is a poison that destroys reason and memory and causes violent choking. It is said of this plant that when its root is surrounded by a hot and burning ash, then a thick smoke rises up in the house; if it reaches the young birds [*pulli*] living in the attic under the roof, they will fall down as if dead, although they still recover later.³³⁶

And it is necessary to know that this corruption of air is diffused much further than the released vapor can be spread out. For the released vapor is not spread out very far because the smoke cannot be thinned out very much. But odor and corruption along with the odor infect the air as far as its distant parts. For if camphor is dispersed in water,³³⁷ its odor will perhaps be perceived in the water to a distance of three hundred cubits, although the camphor's substance cannot be spread out for three hundred cubits, though that material perhaps approaches the rarified thinness of fire. For vultures are sometimes thought to have sensed the stench of corruption that is released from cadavers from five hundred leagues away and to have come to that spot where vultures were never previously seen within a distance of five hundred leagues, owing to the large number of cadavers that fell in that land after some slaughter of men and horses.³³⁸ No smoky evaporation could be spread out to that distance even if it approached the rarified thinness of fire, as we said.³³⁹ But it is necessary to know that smelly and fetid things infect in two ways, namely, from a substance that is capable of evaporating and is smoky and from the qualitative nature of the stench. And in the first way they infect from nearby and by a strong infection,

336 At *De animalibus* 23.1.24.136(98) (ed. H. Stadler, p. 1509), A. indicates that sparrows that eat henbane seeds seem to display symptoms akin to epilepsy, just as here from the smoke alone the chicks collapse.

337 See A., *De veg.* 6.2.4; 3.2.6 (ed. C. Jessen, pp. 492, and 207).

338 A league is a unit of measurement that may vary by region from about 2.5 miles to over 4.5 miles. 500 leagues implies, then, an implausible distance of more than 1,000 miles.

339 See A., *De animalibus* 6.1.6.44-45; 8.2.6.100; 23.1.24.144(113) (ed. H. Stadler p. 459; 613; and 1513); A., *De anima* 2.3.25 (Ed. Colon. p. 135, 32-51).

whereas in the second way they infect only by altering at a great distance and in places where nothing of their smoky evaporation had existed before. But as we said concerning the henbane that corrupts water sources, so flax also operates, although the corruption from flax is less than that from henbane, and this is why fish die in small ponds when flax putrefies in them. But this corruption is diffused further in the air and is particularly prevalent in Africa, as we said in the book *On the Nature of Places*.³⁴⁰ Corruptions of the air are therefore caused from a lower body by these and similar causes.

Sometimes air is also corrupted from a celestial body. For a conjunction of two stars in particular, which are Jupiter and Mars, with others assisting in the sign of Gemini, which is a sign of an airy triplicity, cause pestilent winds and corrupt air, which suddenly kill a large number of men and animals, as was the wind in Adremoth³⁴¹ that suddenly slew one army. For since Jupiter is hot and moist in nature, it has to lift up the winds and vapors and especially in the sign of Gemini, which is a hot and moist sign in the furthest condition [*status*] of the nature of air. But when Mars is intemperately hot and dry, it ignites the elevated vapors, and this is why lightning and flashes begin to multiply throughout the air, and pestilential vapors and fires infect the air with a very sharp poison, and for this reason why they often introduce plagues.

From other similar causes an excessive dryness occurs in air, which sharpens the humors generated in humans, and this is why terrible illnesses and deadly plagues afflict those who live in this air. For corrupt air infects more than does corrupt food or drink, as wise physicians say, because corrupt air passes unaltered to the lungs and the heart and throughout the entire body by means of hidden pores.³⁴² However, food and drink reach the interior vital [organs] only once they have been altered through processes of decoction and digestion.

Let these things then be said by us about corruptions of the air.

CHAPTER TWO

ON THE CORRUPTION OF WATER

FROM THE HEAT OF HOT SPRINGS

But since the previous discussion has already touched on the corruptions of the air, it therefore follows that we should speak about the property by which water is corrupted in terms of quality, since we will have to speak about its tastes elsewhere.³⁴³ Let us speak, then, about the cause of hot springs

340 A., *De nat. loci* 3.5 (Ed. Colon. p. 38,39-44).

341 I.e., the southern part of the Arabian peninsula. See *supra* 2.1.3 (s.v. Adramoth, 104, n. 322).

342 See A., *Quaestiones super de animalibus* 7.32 (Ed. Colon., p. 186,13-60)

343 A., *Meteora* 2.3.13 (Ed. Colon. pp. 94,55-95,35).

in natural terms [*physice*]. For this seems to pertain to us because the ancient naturalists [*naturales*] attempted to discuss them. We will say, however, that we will make a determination in general insofar as suffices for this purpose, because particular hot springs have their own qualities [*passiones*] and accidents, about which it would take long to speak, and it does not pertain to this task, because this does not happen to waters merely insofar as they are hot, but insofar as they are mixed with sulfur or something else of this sort.

First it is necessary to know that *thermae* [hot springs] in Greek means the same thing as *calida* [hot spring] in Latin, and this is why we undertake here to say why some hot springs emerge from the ground. However, Myleus,³⁴⁴ who conducted observations of the stars at Rome and was one of the ancient Italian philosophers, attempted to state the cause, on which many followed him. He said, however, that the cause of the heat in hot springs is that both vapor and wind are enclosed in the hollows in the earth, and these vapors are hot vapors, as is evident in winter, because they warm the waters of springs and wells. Therefore, such vapors are hotter in some places than in others, and in the hollows they are reflected back by the solid surface of the earth into the waters and warm them, and this is why they emerge warm. However, we say against this that Myleus's explanation is unsuitable, because the vapor that is reflected back into the water is local and finite and mixed with the water. However, whatever is mixed with the water emerges with the water. Therefore, that vapor can be exhausted [*finibilis*], and then the heat in the water disappears. But we see that the heat does not disappear; therefore, it was not caused by such a cause, and then Myleus's explanation is not true.

But a certain philosopher, Rentufilos,³⁴⁵ seemed to introduce a cause, in which many people also believed, that is contrary to Myleus's. For he said that in a place with hot springs the ground is loose-textured [*rara*] underneath and has parts that are not knitted together and has a soft bottom, but has a hard outer covering at the surface, since otherwise it could not retain heat. But he said that the sun's rays continuously burn the earth, and he said that this burning is gathered and united in the bowels of the earth on the loose-textured and soft places that have hard surfaces, and for this reason the waters that flow strongly in these places are heated and they emerge as hot. However, using a geometric argument we say against this that the sun when in a downward orbit turns away from any place to the same extent that it draws near to it, as is apparent to anyone who contemplates equally the amount of the sun's downward [orbit] to the south and to the north by means of the shadow lines caused by the sun on geometric instruments. Therefore, if it heats one place in summer, it will cool the same place in winter. If, then, water is heated by the heat of the place

344 Possibly Thales the Milesian, rather than Menelaus. See Vodraska (DCPE, p. 42).

345 Rentufilos/Renufilos is most probably Xenophanes. See Vodraska (DCPE, p. 41).

owing to the sun's heat concentrated in the ground, then that heat will either be diminished or will entirely disappear in winter. But we discover the contrary of this, because we discover that hot springs are equally hot in the four seasons, namely, in winter and autumn and spring and summer, and perhaps with more intense heat in winter than in summer. Therefore, Rentufilos's explanation is unsuitable and false.

Democritus, however, said that the cause for this water's heat is that in the mountains through which the waters pass there are huge quicklime deposits [*montes calcis*], and the quicklime does not have straight but twisted passages in which it retains fire for a long time. And when the water passing through that quicklime is poured over it, the quicklime sounds as if a fire is being extinguished in it, and the water is heated, and this is why hot water emerges at the surface of the ground. And the reason one does not hear the sound of the [fire's] being extinguished is that it occurs in the bowels of the earth and cannot be heard from outside. But the fire that is in the bowels of the earth, according to Democritus, is generated there from the friction of the vapors and wind against the matter of sulfur or white annast,³⁴⁶ and it burns the rocks of the mountain into quicklime, and this is one cause for the generation of quicklime underground, as Democritus said.

However, another cause is that the heat of the sun in oily and viscous ground is sometimes concentrated in the mountain's belly by means of the surrounding cold, and then it burns it into quicklime and sometimes into rocky coals, because if it prevails entirely over the moisture and extracts it, it then turns it into quicklime, but if it does not prevail over it entirely but only divides it and burns it, then it turns it into coals, such as the coal that is found in large quantity near the city of Liège.³⁴⁷ This then is the cause that Democritus assigned.

However, it seems contrary to this explanation that quicklime is only heated when it is roasted with a hot fire and when placed in the fire for a long time, and that then the heat located in it comes forth and makes the water hot when it is poured over it, and that heat is exhausted after a brief time in which the fire located in the quicklime can be extinguished, and then the water's heat ought to have been exhausted. And we do not find this, but rather we find that it has an everlasting heat.

In addition, however, although we have here stated how the fire comes down to the mountain that it burns into quicklime, Democritus still did not state and for this reason does not show how the fire reaches the quicklime that is in the bowels of the mountain. In that way, then, error and inadequacy follows from Democritus's explanation.

346 "White annast": see *supra* 1.2.11, (p. 82), where it is described as a type of bituminous rock that attracts fire.

347 See A., *De nat. loci* 3.2 (Ed. Colon. p. 33,32-33).

But because from the things already said, the error of some of the ancients with respect to the cause of hot springs has been revealed, we now want to offer the explanation that is correct and is directed to the intellect for comprehending it.

Let us say, then, that that water runs over burning veins of sulfur, and on account of this it is heated and emerges hot. An indication of this is that sulfur's odor is always found in the water of hot springs, and sometimes even the taste of sulfur is found in it from the sulfur mixed with the water. For sulfur burns underground easily either from the movement of the earth's vapor, as fire is generated in a cloud, or from the motion and friction of the wind that has entered the ground through certain hollows, or even from the fact that the heat pressed into the ground by the sun's rays is concentrated on one place by the surrounding cold, and then it kindles the materials found in that place, as we said just above. Then fire coalesces in the sulfurous material and oily material and warms the water flowing through it, and this is why it emerges hot.

For if the wick from a candle that has burned and been extinguished is taken before the fire in it completely dies, and sulfur is finely ground up and pulverized over it, the sulfur creates a flame. But in the same way, if glue becomes unbalanced with naphtha and sulfur to form a sort of clay, and lint is dipped in it and is kindled, it will burn as if it can not be extinguished. For naphtha is a kind of pitch that is found in Persia, which has a glutinous and viscous fattiness that is very sticky and is somewhat like the lees of oil. When it is mixed together with sulfur, it becomes inflammable, and its fire adheres in an amazing fashion to whatever it is thrown against, and it can only be extinguished if the whole is covered at the same time. But water does not extinguish it easily, because water does not penetrate it, nor does it adhere to it, owing to the fattiness, and it is through material such as this that the hot water of hot springs passes. But it will be shown in the next chapter how fire is generated in it, because there is one cause of the burning in that material and in the material of a volcano.

But it perhaps bothers someone why that matter is not consumed by the fire and cooled in that way by water. But the reason for this is the continual regeneration of the matter in some place. For sulfur and naphtha are easily generated in a mineral region, and it has been discovered that rainwater descending under the mountains and the foundations of the hot springs is immediately converted into the matter of sulfur and naphtha, and since in this way the matter is regenerated continuously, the fire kindled in it is not extinguished.³⁴⁸

One must note around such places that the place from which that water emerges often has a deep whirlpool so that if very long pieces of wood are placed in it, it draws them into itself within a short time so that they can no longer be seen. Without a doubt the heat does this, because it draws to itself what it touches, and this is why such pieces of wood are sucked in. And an indication of this is

348 See A., *De mineralibus* 4, tr. unic., c. 1 (Borgnet pp. 83-84); 1.1.7 (Borgnet pp. 9-10).

that when there is a small pool of this same water near the opening for this bubbling water and a long thin piece of wood, which can be seized easily from the opening in that pool, is placed at the outside and not near the opening, the heat still draws it to the opening and sucks it in. However, if at times cold water is found to do this, this does not happen because the water draws it to the opening unless it is thrust in the opening, and then if the wood is submerged and sucked in from the opening, this happens because the opening is broad and straight down to the hollow area of the ground from which the water flows; and there is not enough water to be able to support the weight of the wood, nor is the breath forcing the water from the opening strong, and then the weight of the wood gradually prevails over the force of the water, and this is why it gradually sinks.

But there is still something that many are amazed at, namely, that two openings are frequently found located near each another, one of which expels cold water and the other hot, and the reason for this is that, although the external openings are near each another, the interior ones, which are the reservoirs of the waters, are distant from each other, and this is why the water that emerges is diametrically opposite in cold and heat. Also, in winter, when the ground's pores are constricted by cold, and none of the water's heat can evaporate, the water of the hot springs is found to be hotter than in summer, although it always has heat both winter and summer. And for this reason even when it is well covered, the hot water is brought a long distance, because at that time almost none of the heat impressed on it can evaporate at all. However, this water is very drying because of the sulfur that is in it, and this is why both those who suffer from skin diseases [*scabiosi*] and epileptics sometimes use it,³⁴⁹ and it helps them to recover their health.

CHAPTER THREE

ON THE CAUSE OF A VOLCANO

But the cause is similar for the volcano that is in the mountain of Sicily, which is called Aetna and which is above the Great Sea that the Arabs call the *Sceny* sea.³⁵⁰ There is a volcano like it in many places. For there was one that was in the province of Swabia that burned for many years from the fire that shepherds made on it and then later it was extinct, as in our times Aetna is almost completely extinct.³⁵¹ And similarly there is a burning mountain near Liège, and when the rain trickles down upon its edges, smoke rises from it as if from a furnace. All of them burn from the same cause, except that those

349 Epileptics typically suffer from a melancholy complexion, but they may also be beset with a phlegmatic, i.e., cold and moist, complexion and therefore the warm and dessicant nature of the hot springs tempers the phlegmatic moisture.

350 *Sceny* sea, i.e., the Mediterranean. See Vodraska (DCPE, p. 293).

351 A., *De nat. loci* 3.2 (Ed. Colon. p. 36,33).

that are near the sea burn more easily and longer. For the material cause is that the earth is sulfurous and mixed with oily naphtha, and the efficient cause is a vapor that is disturbed in the ground and is unable to emerge. And because the sea water obstructs the ground's pores and openings, for this reason it burns more quickly near the sea than it does elsewhere, and it burns as long as the matter has not been consumed, and it may burn for many years or perpetually if it happens that the matter is continuously replenished. And because a great deal of naphtha has been absorbed by certain rocks, when they are burned they remain very porous and light and float on the water, as pumice does. Let so much then be said about the cause of hot springs and volcanoes, from which it is also seen that the ones that Myleus and Rentyfylos and Democritus mentioned are not true causes.

CHAPTER FOUR

ON THE REFUTATION OF THE VIEW OF THOSE WHO SAID THAT MOUNTAINS AND VALLEYS ARE CAUSED ONLY FROM THE HOLLOW OF THE WATERS

But now we will have to speak about the properties of earth as much as suffices for this purpose. For many things were said about them in the book *On the Nature of Places and their Latitude*.³⁵² But here it is only necessary for us to explain that property that the shape of the earth seems to assume. And this concerns the cause of mountains and valleys.

Some of the most ancient philosophers, however, said that the cause of mountains and valleys on earth was only the motion of the waters. For, they say, in the beginning of its composition the earth was round, having a smooth surface like celestial bodies and having neither mountains nor valleys, but the sea and floods made the mountains. For the sea, which does not always remain in one place, but changes from place to place, as they say, hollowed out loose-textured and soft places, and what it scraped away and removed by inundation, it added to other places, and for this reason the loose-textured, hollowed out places were made into places for rivers and seas, and pits and valleys were formed. But the places where an addition was made became mountains. In like manner, through the motion of waves flood waters hollowed out and formed pits and valleys by inundation and added what was removed to other places, and there mountains were formed. But those who say this agree with those who contend that the sea is changed according to some motion of the celestial sphere, and we have already spoken against them in the previous book of this science, and we disproved there their opinions, and for this reason we will not repeat that debate here. But we

352 A., *De nat. loci* 1.6 (Ed. Colon. pp. 9,47-12,31)

want to speak to their own position against them with arguments founded upon empirical signs and upon geometrical proofs.

Let us say, then, that if water hollowed out the earth, either rainwater descending from the air did this, or the water standing on the earth's surface did this. However, if rain is said to have done this and since the earth is said to have been round from the beginning of its composition or creation, on which there was neither mountain nor valley, then it was necessary according to them that the entire [earth] be turned under water and covered with water across the entire surface in a circuit, as by a garment equally covering it on all sides. If, therefore, rain then fell on it, the rain fell on the water's surface and not on the earth's surface. Therefore, it is necessary that their opinion be such that they thought that this water dripping down from the air upon the water did not cease to penetrate and hollow out the earth little by little, until it made mountains and valleys, and this is completely irrational since the rain water will not have touched the earth or moved it, but it will only have touched the water's surface. But if they should say that the rain water did not do this, but rather that the earth was round and smooth from the beginning of its creation, as we said, and that water stood over it for a certain period of time, covering it equally in a circuit, and finally after some time a wind moved the water and raised up waves, and the earth was hollowed out by these waves, and those waves made its deep place, which is a valley, and its hump, which is a mountain, then something unsuitable follows from that statement, whose contrary is demonstrated.

For we will state against this a necessary natural explanation, to which sight attests. For wind arises only from a dry vapor, and this is why a wind is also calmed by the rain's moisture. If then the earth were entirely covered with water at that time, how could a strong dry vapor be raised up, since the water's moisture would prevent it, and the water's coldness would hold back the earth and would not allow it to evaporate with much vapor? Furthermore, since water would have been a covering of the earth in a circuit, how could the wind have a strong movement? For if it were in the nature of things, as they thought it to be, then the wind would without a doubt have no strong movement at all. Therefore, it is clear in that way that the earth is hollowed with valleys and lifted up with mountains from the beginning of its creation, and the opinion of the opponents has been proven false, and the view of those who thought the contrary has been overturned.

CHAPTER FIVE

AND THIS IS A DIGRESSION EXPLAINING THE ESSENTIAL
CAUSE AND THE ACCIDENTAL CAUSES
OF THE GENERATION OF MOUNTAINS

However, the truth of what is being investigated here concerning the generation of mountains and valleys is that mountains and valleys are generated from two causes, of which one is universal and essential, as it were, and the other is particular, which occurs at some time and in some place.

But the universal and essential cause is that mountains arise from an earthquake, where the earth's surface is solid and compacted and cannot be split.³⁵³ For when strongly increased and agitated, the wind then raises up that place and makes mountains. And because an earthquake frequently has its material [cause] near the sea and near the waters that close the earth's pores so that the earthy vapor enclosed in the bowels of the earth does not evaporate, the highest mountains for this reason most often arise near the sea and near water. But since a concave place underneath a mountain is capable of receiving a lot of water, mountainous places are for this reason most often places pouring forth numerous streams and exuding out large pools. And because the elevated surface becomes solid and indivisible only from a sticky, oily clay, which the water flowing to those places undoubtedly brings, there are for this reason many and large rocks in mountainous places. Their generation comes from such clay and from the heat of the place, which is able to gather heat, whether that heat is generated from the motion of the earthy vapor or generated from the rays of the sun. And an indication of this is that parts of aquatic animals and perhaps of ships' instruments are found in the rocks of mountains in a hollow of the mountain, which the water undoubtedly brought there with oily coated clay, and they are preserved by the coldness and dryness of the rock so that they do not completely putrefy. But strong evidence for this is found in the rocks of Paris, in which there are frequently found round shells and ones of crescent shape and of tortoises.³⁵⁴ Therefore, we say that this is the essential cause of mountains, and where what is raised up in that way is removed, then a valley is caused. But very old mountains, which a strong heat solidified into rock, are dried out on top so that they split and fall in part, unless they have broad bases upon which the upper parts are tapered and lie as if supported on columns or walls.

The accidental cause of mountains is, as often, double, and one cause is of course the inundation of the sea especially, since other waters cannot produce a great inundation. For either with its waves or by its rise and fall, the sea takes a lot of earth or adds it upon other earth and generates a mountain on one side

353 See A., *Meteora* 3.2.18; 3.2.20 (Ed. Colon. pp. 147-50).

354 See A., *De mineralibus* 1.1.2 (Borgnet, p. 3).

and a valley on another side. And what was introduced in the preceding opinion contributes to this, that is, that the earth is soft and loose-textured and can be eroded, and this is why valleys are produced in it rather frequently and mountains next to it where [the earth] is harder and more cohesive and cannot be shaved off.

But there is another accidental cause in sandy, broad and windblown earth. For winds frequently gather sand there from one place and deposit it on another place, and then a small or large mountain is produced there depending on the quantity of sand. And if it happens that viscous moisture is poured out there, this will be solidified into rock by the mineral power that is in the grains of sand, and for this reason the grains of sand will begin to cling to one another so that they will be like one rock. However, if such moisture is not present there, the grains of sand will remain distinct, not clinging to one another except perhaps on the surface because of the roots of the plants generated there.

Let these things, then, be said about the cause of mountains and valleys, since it will be necessary for us to say more things pertaining to these matters in the book *On Minerals*³⁵⁵ and in the book *On Meteors*.³⁵⁶

CHAPTER SIX

IN WHICH THE EARTH IS SHOWN TO BE AT REST FROM A DESCRIPTION OF CERTAIN SEAS AND RIVERS

But because we have already achieved our purpose from an investigation of the causes of the properties of the elements, which has been briefly explained causally in a universal sense, and because we have shown that the statements of certain ancient wise naturalists [*physiologorum*] are not suitable, it now remains to discuss the places of the earth in a singular and specific way, that is, what their nature is and what the nature of all the different seas that are on earth is. And it remains to discuss the source of rivers and their flow and the nature of cities and the position of regions based on their longitude and latitude, and the nature that places have by accident from the fact that they are on the shores of seas or at the mouths of rivers in order to distinguish the nature of one place from another, insofar as suffices for the present purpose. And this is so that anyone reading the things said here may understand explicitly the error of those who say that they know the nature of things and particularly concerning the elements, like one who said that the earth is moved and is not at rest, as Pythagoras said,³⁵⁷ and so that the error may be destroyed of the one who said that the sea and the rivers are moved from place to place according to the movement of the spheres, and who said that the movement of the seas and of

355 See A., *De mineralibus* 1.1.2-4 (Borgnet, pp. 3-7).

356 See A., *Meteora* 3.2.18 (Ed. Colon. pp. 147-48)

357 See A., *De caelo et mundo* 2.4.8 (Ed. Colon. p. 195, 52 with note).

streams is not caused by one single movement of any celestial body, but is caused by the universal general movement of all the celestial bodies.

But the cause by which is known why the sea is salty and rivers are either salty or fresh should not be determined here, but rather in the book *On Meteors*.³⁵⁸

But we have already determined in the book *On the Nature of Places*, which is caused by their longitude and latitude, the knowledge of the nature of places and cities that stems from their longitude and latitude in relation to one another and how many feet one place is distant from another based on longitude and latitude. For the distance in feet is known from the number of miles and leagues, and we showed in that book how the visible horizon of one place varies from the horizon at another place in terms of the number of miles and leagues.³⁵⁹ But we said that the intelligible horizon of any place is different from the horizon of another place. However, with regard to the question that we already hinted at earlier in this chapter, we turn to destroy briefly the position of the one who said that the earth is moved and not at rest. For when the earth is moved, it is necessary that the sea and rivers that stand on it also be moved continuously. It follows, therefore, from this that all the waters of the seas and the streams are mixed together, and in accord with this it is necessary that either all the waters will be salty if saltiness prevails in them from the mixing of salt waters with fresh waters, or they will all be fresh if a freshness prevails in them from the same mixing. It would also be necessary that the earth has long since in past ages been set free from its shape because of motion, since we see with our own eyes that the whole earth is not moved at the same time. If, then, its parts are moved, then one part will be divided from [another] part and its shape will be destroyed, and this follows from the statement of the one who said that the earth is lifted up in the south and lowered in the north, since if the earth is lifted up in the south, then it is outside its natural place and rests there violently, and the northern part will naturally tend to its place and will be separated from the southern part, and in this way one half of the earth will be divided from the other, and neither will have a spherical shape, but each will be like a semicircle. And if it is moved, then the waters will be mixed, and then the one taste will prevail in the waters, which belongs to that water that dominates in the mixture of the waters, and then either all the waters will be salty or all will be fresh or all will have a taste of sulfur or arsenic. However, we experience none of these things with the senses.

And if perhaps someone should perhaps say that although they are not mixed now, they still were at some time mixed and will be mixed again at some point, we will say that then someone ought to have indicated something about such a mixture of waters in the past, because such a mixture would be surprising, and

358 See A., *Meteora* 2.3.15-16 (Ed. Colon. pp. 96-98).

359 A., *De nat. loci* 1.10 (Ed. Colon. p. 17,62-79).

many would have been amazed at it and would have investigated and written about its cause.

And because we have said enough about these things, we wish to describe some places of ancient seas and rivers by a visible shape, from whose disposition and order every false opinion may be refuted that states that the seas and rivers are mixed and brought together into one from the earth's motion.

Let me circumscribe the circle of the Ocean, then, which is called Amphitrites,³⁶⁰ and which contains the entire sphere of the earth from pole to pole by flowing through the eastern point and the western point, and let me extend a bay [*gumphus*], that is, a certain part of the sea, which is the Mediterranean Sea, from Amphitrites between the south and the east, which is called Syn, which is the Indian Sea. And if it is extended further, then it is the sea that is called in Arabic *Allebila*, which we call the Persian Gulf, because these two seas are continuous, and as we said above, the Tigris and Euphrates, coming from a northern direction, enter into this Persian Gulf. For the source of the Euphrates comes from the northern mountains of Greater Armenia, and the source of the Tigris comes from the northern fields of India.³⁶¹ But from the Indian Sea, which is continuous with the Persian Gulf, there comes yet another bay, which is its second bay, and this is the Red Sea more toward the south than the Persian Gulf is and next to Egypt. But from the sea that contains the sphere of the earth, which is called the Ocean and Amphitrites, a very large bay emerges from a western direction, which is called in Arabic the *Sceny* Sea and among us is called the Great Sea or that of the land of Italy.³⁶² But it travels as far as the Pyrenees mountains along the entire length of Italy, which is called the land of the Romans, and it turns back to the east and the north from the one side to the other side of Italy, where Constantinople is on one shore and Venice is near the other shore, and it stretches out to Fréjus³⁶³ [*Forum Julii*] and to Aquileia and those parts, and for this reason that sea is said to be continuous with the land of the Romans. And a bay again comes out of the Ocean containing the earth's sphere, that in Arabic is called *Berdyl*,³⁶⁴ and it is said to divide the land of the Romans, which is Italy, and this sea is nothing but a turning back of the one that was mentioned earlier,

360 In Greek mythology, Amphitrite was a sea goddess, and in Roman mythology she was Neptune's wife. See A., *De caelo et mundo* 2.2.3 (Ed. Colon. p. 131,9); *De nat. loc.* 1.9 (ed. Col. p. 17, 68).

361 A., *De nat. loci* 3.1 (Ed. Colon. p. 31,4-5).

362 The *Sceny* is, again, the Mediterranean. See Vodraska (DCPE, p. 293).

363 Fréjus, a seaside town on the French Riviera in the province of Narbonne, about 20 miles S.W. of Cannes, known as *Forum Julii*. Cf. *Abbreviationes Chronicorum*, in *Radulfi de Diceto Decani Landoniensis Opera Historica*, ed. William Stubbs, 2 vols. (London: Longman & Co., 1876), 1:9.

364 In DCPE, *mare berdil*, literally the "Sea of Bordeaux," which is said to divide the land of the Romans (i.e., the Byzantine Empire). See Vodraska (DCPE, p. 45).

which is turned back toward the shore that is between the east and the north of the Roman lands. But a certain gulf comes out of Amphitrites, which is the sea containing the earth's sphere, and it is called in Arabic *Deylim*.³⁶⁵ Its boundary extends to the part of the south that is called in Arabic the land of *Corassem*,³⁶⁶ and this is the sea that touches England and Dacia and comes near to Germany toward Livonia³⁶⁷ and there it curves in a circuit to the south, namely, between the east and the south. However, from antiquity these seas, which are the principal mediterranean ones, have been found to be always distinct and never mixed. But the source of the Euphrates is, as we said, from a northern mountain of Armenia and descends to the eastern land of the Arabs, which is called Baghdad, and the source of the Tigris is from the northern land of India, which is in a direct line with the land of the Romans to the east, and it flows together into the Euphrates below the place that is called Baghdad, and then they empty together into the Persian Sea. Likewise, the Nile emerges from Ethiopia and flows toward Egypt, and below Alexandria it empties into the Great Sea. But the Gyon emerges from a mountain that is called *Rasyn* in Arabic³⁶⁸ and is in southern India, and it turns back and empties into the Ocean to the east.

However, I want to show these regions and places in a sketch [see Figure 2, next page]. I will then put point "A" to be the place of the Indian Sea, which is called Syn. And I will put point "B" as a marker for India, which is above that sea. And I will put point "C" to designate the place and habitation of Persia. And I will put point "I" as the habitation of the earth that is called in Arabic *Lihagez*.³⁶⁹ And I will put point "K" to designate the Great Sea, which is called *Sceny* in Arabic. And I will say that point "D" indicates the place that is called Iraq [*Yrac*]. And I will say that point "F" stands for the land of the Romans or Italy. And I will say that point "T" designates Spain. And I will say that point "G-D" stands for Ethiopia. And I will say that the two points "M-H" represent the island of Deylis,³⁷⁰ and this is a large island. And I will say that point "E" represents two places called in Arabic *Basarati*³⁷¹ and *Alcufati*,³⁷² which are to the

365 Vodraska (DCPE, p. 226) identifies *Deilim/Deylim* as the Caspian Sea.

366 *Corassem/Chorasem*, i.e. Khorasan (the eastern portion of ancient Persia). See Vodraska (DCPE, p. 226).

367 The area of Germany across the Finnish Gulf

368 Vodraska (DCPE, p. 292) identifies the river *Gyon/Geon* as the present Āmū Daryā river in south-central Asia.

369 Vodraska (DCPE, p. 286) identifies this as al-Hidjās, in the north west of Saudi Arabia.

370 Vodraska (DCPE, p. 50) cannot positively identify this island, but suggests that it will be found in the Indian Ocean.

371 I.e., al-Basra. See Vodraska (DCPE, p. 289).

372 I.e., al-Kūfa, a city on the Euphrates S.E. of Baghdad. See Vodraska (DCPE, p. 285).

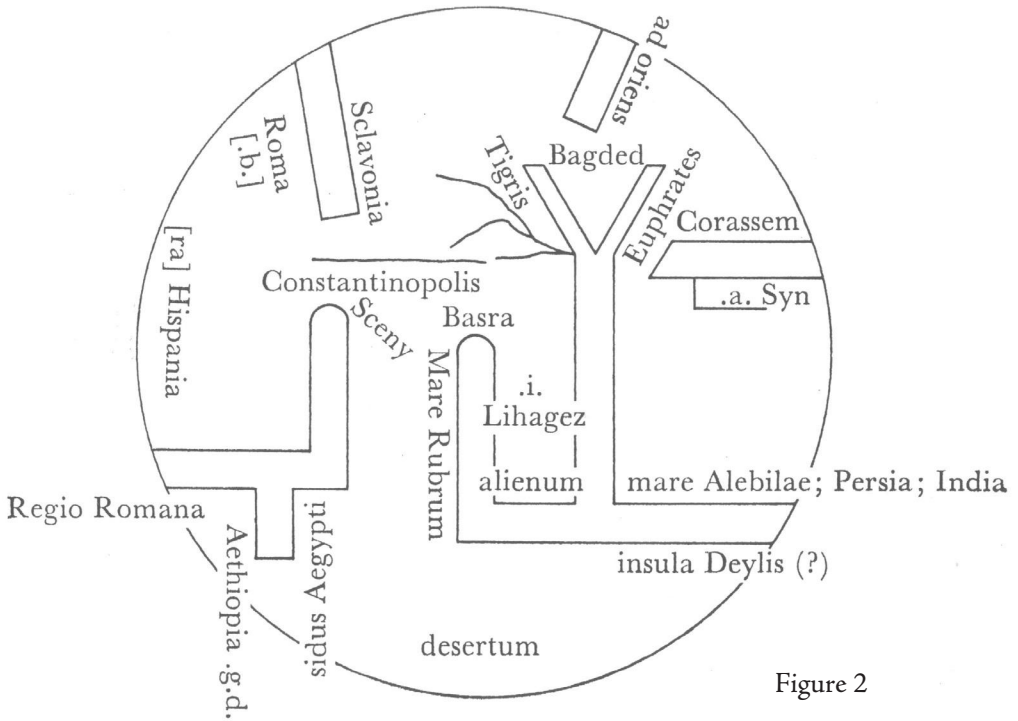


Figure 2

Source: Ed. Colon. p. 104.

west toward the place that is called Baghdad. For we say that Baghdad is a place between the Tigris and Euphrates, where they flow into one another. And I will say that point "N" signifies Constantinople, which formerly was called Byzantium, and there is a sketch of this description that is depicted at the end of this book.

We have, however, dismissed an account of many seas and rivers and cities because there is enough from what we have introduced for proving our goal, namely, that the earth is not moved, but its places remain distinct, and that neither rivers nor the seas are mixed.

It is, therefore, not necessary for us to tarry over such things here because we already named all such places in the *Book on the Longitude and Latitude of Places*,³⁷³ and we distinguished their natures there and the division of cities from one another according to the measure of longitude and latitude, and we determined the rivers and mountains as best we could, while striving for brevity. Since, then, we have pursued all that we wished to concerning the causes of the properties of the elements, it is time for us to make a determination concerning the generation and corruption of bodies. For since we made a determination

373 A., *De nat. loci* tr. 3 (Ed. Colon. pp. 29,1-44,60)

regarding moveable [body] considered absolutely in the book on the *Physics*³⁷⁴ and on moveable body with respect to place in the book *Of Heaven and Earth*,³⁷⁵ and since we discussed the relationship of something that moves in a rectilinear fashion to one that moves in a circular fashion in the book *On the Longitude and Latitude of Places*,³⁷⁶ and now since in this book we have made a determination concerning the properties of simple bodies that are caused in them from the fact that they relate to one another in different ways, a division that we mentioned at the beginning of our [book on] *Natures*,³⁷⁷ demands that we discuss, God willing, the generation and corruption of things subject to generation and corruption.³⁷⁸

374 See A., *Phys.* 1.1.4 (Ed. Colon. p. 6,39-8,14).

375 See A., *De caelo et mundo* 1.1.1 (Ed. Colon. p. 1,6-2,79)

376 See A., *De nat. loci* 1.5 (Ed. Colon. pp. 8,43-9,37).

377 See A., *Phys.* 1.1.4 (Ed. Colon. p. 6,39-8,14).

378 That is, in the book *On Generation and Corruption* (*De generatione et corruptione*). See A., *De gen. et corr.* (Ed. Colon. pp. 109,1-213,20).

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